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NEW LOCOMOTIVE AND CAR SHOPS.

COLLINWOOD, OHIO.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

V.

THE MACHINE TOOL EQUIPMENT.

POWER FOR THE TOOLS.

When the design of the machine tool equipment and layout for the machine shops at Collinwood was under consideration a great deal of difficulty was occasioned by the general scarcity of information and data available regarding the powering of most kinds of machine tools, and the best methods of driving them. A large amount of study was necessary to perfect these details and to arrive at the best possible solutions of the questions, particularly as there was at the time very little precedent to follow.

Probably the most important question was the powering of the tools. A large amount of very valuable data was gathered on this subject during the original investigations, in connection with the determination of the generator capacity necessary to be installed in the central power plant to operate the entire power system. The power that would be required to run each of the machine tools to be installed at the shops was carefully estimated from the best of the data obtainable, for the purpose of first determining as nearly as possible the proper sizes of motors for running them. These estimated power inputs were based upon the full-load capacities of the respective tools—a value which is rather indefinite with most machine tools, being dependent usually upon the product of the size of the heaviest cut and the highest cutting speed, or, in other words, upon the highest rate of removal of metal. The estimated required powers for each tool installed appear, as adopted, in the accompanying tool list presented on pages 42 and 43. It is to be noted that in the list of direct-connected tools these estimated powers appear in the left-hand column, the outside column to the extreme right indicating the sizes of motors actually applied finally to each of the tools.

The direct-connected tools are equipped with motors of capacities anywhere from 60 to 300 per cent. of their estimated required powers, according to the tool and to the work for which they were to be used. This difference is caused by the excess of powering required by the multiple-voltage system, as will be afterwards explained, and also in some cases by the expectation of a slightly greater power to be required than previously estimated.

Such tools as planers, shapers, grinders, blowers, etc., which require their full power continuously when in operation, are equipped with motors of exactly 100 per cent. of their maximum powers. In the cases of the smaller machine tools which are group-driven from line-shafting, each group is driven by a ceiling-type line-shaft motor of a capacity equal to something less than the sum of the maximum powers of all the tools in the group, the desired percentage of power in the motor being 75 per cent.; this percentage was not adhered to, however, for practical reasons. The majority of the groups were equipped with motors of larger sizes than had been estimated as necessary in order to provide in advance for extensions. Some of the groups are powered as high as 140 per cent. and 160 per cent. of their present required power.

The method of arriving at the generator capacity necessary in the power plant to take care of the machine shop motors is interesting. The motors which are direct-connected to machine tools, operating with variable loads, were estimated to require about 30 per cent. of the rated horse power of the tool, the transmission loss being estimated at 20 per cent.; this made the power actually required about 36 per cent. of the total power. The constant-load tools, such as the planers, blowers, etc., were figured at 100 per cent. of their full powers, with a 20 per cent. allowance for transmission losses. The group-driven tools were estimated to require, at their motor, about 50 per cent. of the power that would be required to run all the tools of the group at full load, this figure including all losses in transmission, both electrical and mechanical. The total crane, turntable, transfer table and elevator load that the power plant generators will be called upon to carry was estimated flatly at 75 kilowatts, a quantity based upon experience at other plants; it is more than probable that, with the generous overload capacity that is provided in the generators, no combination of circumstances will ever arise to cause a sufficient overload from the cranes to seriously affect them.

GENERATOR CAPACITY REQUIRED.

It is interesting to note in this connection the relation of the total generator capacity arranged for in the power plant to the total power actually required by the various departments of the shop for both lighting and machine driving. As will be recalled from the description of the power plant in our November, 1902, issue, the capacities of the generators installed are 400-kw., 400-kw. and 75-kw., making a total capacity of 875 kw. (1,167 h.p.). These machines are all designed to easily withstand overloads of 25 per cent., and will even carry overloads of 75 per cent. momentarily without serious inconvenience; thus the power plant can easily take care of a steady overload of 1,094 kw. (1,460 h.p.), and may withstand momentarily a load as high as 1,532 kw. (2,043 h.p.). The power that will be demanded for lighting and machine driving in the various departments of the shops is given in the table appended below, subdivided into constant loads, variable loads, cranes and lighting:

ESTIMATE OF POWER REQUIRED AT COLLINWOOD SHOPS.

A.—For Machine-Tool Driving—Constant Load:
(Estimated—Load factor, 100 per cent.; transmission efficiency, 80 per cent.)

Locomotive shops building	45 H. P.	42.2 Kw.	
Blacksmith shop building	60 H. P.	56.2 Kw.	
Car shops buildings	100 H. P.	93.7 Kw.	
Total	205 H. P.		192.1 Kw.

B.—For Machine-Tool Driving—Variable Loads:
(Estimated—Load factor, 30 per cent.; transmission efficiency, 80 per cent.)

Locomotive shops building	715.3 H. P.	201.1 Kw.	
Blacksmith shop building	363.0 H. P.	102.1 Kw.	
Car shops buildings	451.5 H. P.	127.0 Kw.	
Power plant (coal crusher, etc.)	27.5 H. P.	7.7 Kw.	
Total	1,557.3 H. P.		437.9 Kw

C.—For Cranes, Transfer Tables, Etc:	Power Estimated.	
100-ton erecting shop traveling crane	30 Kw.	
30-ton boiler shop traveling crane	10 Kw.	
7½ and 10-ton locomotive shops cranes	5 Kw.	
Turntables, 72 ft. (roundhouse and loco. shops)	5 Kw.	
Transfer tables, 75 ft. (two for car shops)	10 Kw.	
Elevator (5,000-lb. electric for storehouse)	2 Kw.	
Total		62.0 Kw.

D.—For Electric Lighting—All-Night Load:
(Estimated—Load factor and transmission efficiency, 100 per cent. total.)

	Arcs.	Incand'ts.		
Shops and shop yard	33	152	27.4 Kw.	
Roundhouse and yard	6	274	17.3 Kw.	
Transportation department	45	60	30.0 Kw.	
Total	84	486		74.7 Kw.

LIST OF TOOLS AND MOTORS.

COLLINWOOD SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

LOCOMOTIVE DEPARTMENT, DIRECT-CONNECTED TOOLS.

No.	Tool.	Maker.	H. P. Required.	H. P. of Motor Applied.
	TESTING LABORATORY.			
83	20,000-lb. testing machine	Riehle Bros.	...	7.5
	MACHINE SHOP.			
8	84-in. boring mill	Niles Tool Works Co	3.5	M.V., 10
9	51-in. boring mill	Niles Tool Works Co	3.5	M.V., 7.5
10	84-in. driving wheel lathe	Niles Tool Works Co	8	M.V., 15
11	84-in. driving wheel lathe	Niles Tool Works Co	8	M.V., 15
12	Driving wheel quartering machine	Niles Tool Works Co	6	5—5
14	Frame slotting machine	Bement-Miles & Co	20	M.V., 20
15	54-in. x 54-in. x 32-ft. frame planer	Pond Machine Tool Co	20	20
16	Locomotive rod boring machine	Niles Tool Works Co	6	M.V., 5
17	36-in. x 36-in. x 10-ft. planer	Pond Machine Tool Co	7.5	M.V., 7.5
18	60-in. horizontal boring machine	Niles Tool Works Co	2.5	M.V., 5
19	24-in. gearer slotter	Niles Tool Works Co	8.7	M.V., 7.5
20	No. 3 vertical spindle milling machine	Newton Machine Tool Co	7.5	M.V., 10
21	No. 4 special plain milling machine	Newton Machine Tool Co	7.5	M.V., 10
30	84-in. driving wheel lathe	Niles Tool Works Co	8	M.V., 15
31	28-in. x 12-ft. 6-in. bed engine lathe	Pond Machine Tool Co	3.5	M.V., 7.5
32	28-in. x 12-ft. 6-in. bed engine lathe	Pond Machine Tool Co	3.5	M.V., 7.5
33	32-inch x 16-ft. bed engine lathe	Pond Machine Tool Co	3.5	M.V., 7.5
34	36-in. triple geared engine lathe	Pond Machine Tool Co	5	M.V., 7.5
35	28-in.—48-in. extension gap lathe	Edw. Harrington Son & Co	3.5	M.V., 7.5
36	42-in. x 16-ft. triple geared engine lathe	Pond (Old Tool)	5	M.V., 10
37	42-in. x 42-in. x 10-ft. planer	Niles (Old Tool)	12	10
38	No. 2 6-ft. radial drill	Niles Tool Works Co	5	3
39	88-in. hydrostatic wheel press, 300-ton	Elkhart Shops (Old Tool)	10	10
40	Driving axle lathe	Niles (Old Tool)	5	M.V., 10
41	48-in. hydrostatic wheel press, 150-ton	Niles Tool Works Co	7.5	M.V., 10
42	48-in. radial drill	Prentice Bros. Co	5	3
44	36-in. x 36-in. x 8-ft. open side planer	Detrich & Harvey Machine Co	10	10
45	38-in. x 38-in. x 10-ft. planer	Niles (Old Tool)	10	7.5
46	42-in. x 42-in. x 12-ft. planer	G. A. Gray & Co	12	M.V., 15
47	No. 4 plain milling machine	Newton Machine Tool Co	7.5	M.V., 10
48	60-in. horizontal boring machine	Niles Tool Works	2.5	M.V., 5
49	84-in. boring mill	Niles Tool Works	3.5	M.V., 10
50	28-in. x 12-ft. 6-in. engine lathe	Pond Machine Tool Co	3.5	M.V., 7.5
51	30-in. x 16-ft. engine lathe	Pond (Old Tool)	3.5	M.V., 7.5
52	36-in. x 16-ft. engine lathe	Pond (Old Tool)	5	M.V., 7.5
53	42-in. x 18-ft. triple geared engine lathe	Pond Machine Tool Co	5	M.V., 10
54	36-in.—60-in. extension gap lathe	Edw. Harrington Son & Co	5	M.V., 7.5
70	42-in. car wheel lathe	Pond Machine Tool Co	9	M.V., 20
71	37-in. boring mill	Bullard Machine Tool Co	3.5	5
72	37-in. boring mill	Bullard Machine Tool Co	3.5	5
73	Portable cylinder boring machine	Bullard (Old Tool)	1	
76	Arbor driven cold saw	Q. & C. Ry. Supply Co	3.5	7.5
77	42-in. car wheel boring machine	Putnam Machine Co	3.5	7.5
78	Double car axle lathe	Putnam Machine Co	7.5	M.V., 15
79	16-in. slotting machine	Niles Tool Works Co	4.5	M.V., 10
82	26-in. triple geared shaper	Cincinnati Shaper Co	3	3
89	Gardner disc grinder	C. H. Besly & Co	5	5
90	18-in. x 2-in. emery grinder	C. H. Besly & Co	3	
94	45-in. smoke exhauster fan	Buffalo Forge Co	15	15
	BOILER SHOP.			
22	Single No. 2 punch	Long & Allstatter Co	5.5	5
23	Single No. 2 shear	Long & Allstatter Co	5.5	5
24	12-ft. 2-in. x ⅞-in. bending rolls	Bement-Miles Co.	30	{ 15 M.V., 20
25	No. 3 plate straightening rolls	Niles Tool Works Co	7.5	M.V., 10
28	¾-in. single No. 4 punch	Long & Allstatter Co	3	3
29	Single No. 4 shear	Long & Allstatter Co	3	3
43	No. 2 bevel rotary shear	Lenox Machine Co	7.5	M.V., 10
55	9-in. horizontal flange punch	Niles (Old Tool)	5.5	5
56	Four-spindle multiple drill	Niles Tool Works Co	8	7.5
57	36-in. throat multiple punch	Cincinnati Punch & Sh. Wks Co.	7.5	7.5
80	No. 2 6-ft radial drill	Niles (Old Tool)	5	
84	No. 2 plate bending roll	Hilles & Jones	10	M.V., 10
85	Flue rattler	Elkhart Shops	12	
98	No. 6 pressure blower, flue furnace	Buffalo Forge Co	6	6.5
99	No. 6 pressure blower, flange furnace	Buffalo Forge Co	6	6.5
	BLACKSMITH SHOP.			
67	No. 6 bulldozer	Williams & White	15	20
68	No. 8 bulldozer	Williams & White	25	25
69	3½-in. forging machine	Blakeslee	10	
86	Combined punch and shear		5	
87	Bar shear	Hilles & Jones	10	15
96	No. 7 pressure blower, bulldozers	Buffalo Forge Co	9	9.5
97	No. 6 pressure blower, spring shop	Buffalo Forge Co	6	6.5
100	No. ½ blower, case hardening furnace	Root		

BOLT SHOP.

No.	Tool.	Maker.	H. P. Required.	H. P. of Motor Applied.
74	No. 3 3-in. bar shear	Cincinnati Punch & Sh. Wks Co.	5	10
95	No. 6 pressure blower	Buffalo Forge Co	6	6.5
	SCRAP PLATFORM.			
88	Scrap shear		10	

LOCOMOTIVE DEPARTMENT—GROUP DRIVEN TOOLS.

No.	Tool.	Maker.	H. P. Required per Machine.
	GROUP A. MACHINE SHOP, GRINDING ROOM—DRIVEN BY A 25 H. P. MOTOR.		
218	Buffing and polishing wheel 30-in x 8-in	Elkhart Shop	15
219	Buffing and polishing wheel 30-in. x 8-in	Elkhart Shop	15
		Total	30
	GROUP B. MACHINE SHOP, GRINDING ROOM—DRIVEN BY A 25 H. P. MOTOR.		
216	Grindstone 84-in. x 16-in	Manning, Maxwell & Moore	15
217	Grindstone 84-in. x 16-in	Manning, Maxwell & Moore	15
		Total	30
	GROUP C. MACHINE SHOP, ROD DEPARTMENT—DRIVEN BY A 25 H. P. MOTOR.		
116	Two-spindle Whiton centering machine	U. Baird Machine Co	.8
121	Sensitive drill No. 4	Barr Mfg. Co	.5
124	21-in. Standard drill press	Prentice Bros. Co	.75
133	32-in. Standard drill press	Niles Tool Works Co	2
136	32-in. Standard drill press	Niles Tool Works Co	2
151	26-in. triple geared shaper	Cincinnati Shaper Co	2.5
157	16-in. slotting machine	Niles Tool Works Co	3
168	16-in x 6-ft. engine lathe	Prentice Bros. Co.	1
170	16-in x 8-ft. engine lathe	Prentice Bros. Co.	1
180	21-in. x 10-ft. engine lathe	Prentice Bros. Co.	2
183	24-in. x 10-ft. engine lathe	Ed E. Reed Co	2
211	No. 2 swinging grind. and polish. mach	Niles Tool Works Co	3
213	No. 2 plain milling machine	Newton Machine Co	3
224	Oscillating surface grinder	Springfield Mfg. Co	4
		Total	27.55
	GROUP D. MACHINE SHOP, MOTION WORK DEPARTMENT—DRIVEN BY A 10 H.P. MOTOR.		
129	30-in. Standard drill press	Prentice Bros. Co.	1
130	32-in. Standard drill press	Niles Tool Works Co	2
134	32-in. Standard drill press	Niles Tool Works Co	2
154	20-in. x 50-in. open side shaper & planer	Richards (Old Tool)	3
172	16-in. x 8-ft. engine lathe	Prentice Bros. Co.	1
175	21-in. x 10-ft. engine lathe	Prentice Bros. Co.	2
179	21-in. x 10-ft. engine lathe	Prentice Bros. Co.	2
220	Link grinder	L. C. Hammett & Co	3
		Total	16
	GROUP E. MACHINE SHOP, GENERAL WORK—DRIVEN BY A 15 H. P. MOTOR.		
152	26-in. triple geared shaper	Niles (Old Tool)	2.5
153	20-in. x 50-in. open side shaper & planer	Walker Mfg. Co	3
156	16-in. slotting machine	Niles Tool Works Co	3
160	No. 4 Universal milling machine	Brown & Sharp Mfg. Co	3
177	21-in. x 10-ft. engine lathe	Prentice Bros. Co.	2
178	21-in. x 10-ft. engine lathe	Prentice Bros. Co.	2
206	No. 2 Keyseat driller	Bement-Miles & Co	1
230	18-in. x 96-in. plain grinder	Norton Grinding Co	5
		Total	21.5
	GROUP F. MACHINE SHOP, TOOL DEPARTMENT—DRIVEN BY A 20 H. P. MOTOR.		
117	Bench drill	(Old Tool)	.5
119	Sensitive drill No. 4	Barr Mfg. Co	.5
126	21-in. drill press	Prentice Bros. Co.	.75
127	24-in. drill press	Prentice Bros. Co.	1
138	Universal tool grinder	Wm. Sellers & Co	4
139	No. 3 Universal grinder	Brown & Sharp Mfg. Co	3
141	Reamer grinder	(Old Tool)	1
155	15-in. shaper	Hendey Machine Co	3
159	No. 3 Universal milling machine	Brown & Sharp Mfg. Co	2
161	14-in. x 6-ft. tool room lathe	Pratt & Whitney	1
162	14-in. x 6-ft. tool room lathe	Pratt & Whitney	1
163	14-in. x 8-ft. tool room lathe	Pratt & Whitney	1
174	21-in. x 10-ft. engine lathe	Prentice Bros. Co.	2
222	Walker cutter grinder	Norton Emery Wheel Co	3
		Total	23.75

GROUP G. MACHINE SHOP, BRASS DEPARTMENT—DRIVEN BY A 25 H. P. MOTOR.

No.	Tool.	Maker.	H. P. Required. Per Machine.
118	Bench drill	(Old Tool)	.5
120	Sensitive drill No. 4	Barr Mfg. Co.	.5
128	24-in. Standard drill press	Niles Tool Works Co.	2
140	Cock grinder	Warner & Swasey	1
158	Two-spindle valve milling machine	Warner & Swasey	2
167	16-in. x 6-ft. engine lathe	Prentice Bros. Co.	1
173	21in. x 10-ft. engine lathe with tapering attachment	Prentice Bros. Co.	2
182	24-in. x 10-ft. engine lathe	Ed E. Reed Co.	2
185	27-in. x 10-ft. engine lathe with tapering attachment	Ed E. Reed Co.	2
187	No. 2 cabinet lathe	American Tool & Machine Co (Old Tool)	.75
188	16-in. geared friction head forming monitor lathe	Warner & Swasey	2.5
189	16-in. geared friction head forming monitor lathe	Warner & Swasey	2.5
202	No. 2 cabinet turret lathe	American (Old Tool)	.75
209	No. 2 cabinet lathe	American	.75
210	No. 2 cabinet lathe	American	.75
		Total	21.

GROUP H. MACHINE SHOP, BOLT DEPARTMENT—DRIVEN BY A 25 H. P. MOTOR.

No.	Tool.	Maker.	H. P.
115	Two-spindle Whiton centering machine	U. Baird Machine Co.	.8
144	No. 4 turret bolt cutter	Pratt & Whitney	2
145	1½-in. double head bolt cutter	Acme Machinery Co (Old Tool)	2.5
148	1½-in. nut facing machine	Acme Machinery Co.	2.5
149	2½-in. nut facing machine	Acme Machinery Co.	2.5
150	Automatic screw machine	Cleveland Machine Screw Co.	2.5
164	16-in. x 6-ft. engine lathe with tapering attachment	Prentice Bros. Co.	1
165	16-in. x 6-ft. engine lathe	Prentice Bros. Co.	1
166	16-in. x 6-ft. engine lathe	Prentice Bros. Co.	1
169	16-in. x 6-ft. engine lathe	Prentice Bros. Co.	1
190	2-in. x 24-in. turret lathe	Jones & Lampson (Old Tool)	3
191	Hollow hexagon turret lathe	Warner & Swasey	3
192	Hollow hexagon turret lathe	Warner & Swasey	3
193	Hollow hexagon turret lathe	Warner & Swasey	3
204	Four-spindle staybolt cutter	Acme Machinery Co.	5
221	Two-spindle staybolt cutter	Acme Machinery Co.	3
		Total	36.8

GROUP I. BOILER SHOP, FLUE DEPARTMENT—DRIVEN BY A 10 H. P. MOTOR.

No.	Tool.	Maker.	H. P.
195	Flue welding machine	Hartz	3
196	Flue welding machine	Hartz	3
		Total	6

GROUP J. MACHINE SHOP, GENERAL WORK—DRIVEN BY A 10 H. P. MOTOR.

No.	Tool.	Maker.	H. P.
114	37-in. boring mill	Niles Tool Works Co.	3.5
122	Two-spindle sensitive drill	Foote & Burt	.5
137	No. 5 drill	Niles (Old Tool)	3
146	2½-in. bolt cutter and nut tapper	Acme Machinery Co.	2.5
147	2-in. six-spindle nut tapper	Acme Machinery Co.	2.5
176	21-in. x 10-ft. engine lathe	Prentice Bros. Co.	2
181	24-in. x 10-ft. engine lathe with tapering attachment	Ed E. Reed Co.	2
186	27-in. x 10-ft. engine lathe	Ed E. Reed Co.	2
		Total	18

GROUP K. MACHINE SHOP, AIR PUMP DEPARTMENT—DRIVEN BY A 15 H. P. MOTOR.

No.	Tool.	Maker.	H. P.
123	Two-spindle sensitive drill	Foote & Burt	.5
131	32-in. Standard drill press	Niles Tool Works Co.	2
171	16-in. x 8-ft. engine lathe with tapering attachment	Prentice Bros. Co.	1
184	24-in. x 10-ft. engine lathe	Ed E. Reed Co.	2
201	16-in. back geared shaper	Cincinnati Shaper Co.	3
212	42-in. power squaring shears	Manning, Maxwell & Moore	1
214	6-in. pipe cutting machine	Jarecki Mfg. Co.	4
215	3-in. pipe cutting machine	Jarecki Mfg. Co.	2
		Total	15.5

GROUP L. MACHINE SHOP, GENERAL WORK—DRIVEN BY A 7.5 H. P. MOTOR.

No.	Tool.	Maker.	H. P.
125	21-in. Standard drill press	Niles Tool Works Co.	1.5
132	32-in. Standard drill press	Niles Tool Works Co.	2
135	32-in. Standard drill press	Niles Tool Works Co.	2
		Total	5.5

GROUP M. BLACKSMITH SHOP—DRIVEN BY A 50 H. P. MOTOR.

No.	Tool.	Maker.	H. P. Required. Per Machine.
101	No. 11 volume blower	Buffalo Forge Co.	32
102	110-in. steel plate exhauster	Buffalo Forge Co.	23
		Total	55

GROUP N. BLACKSMITH SHOP, BOLT SHOP—DRIVEN BY A 20 H. P. MOTOR.

No.	Tool.	Maker.	H. P.
231	1½-in. bolt header	Acme Machinery Co.	5.5
232	1½-in. bolt header	Acme (Old Tool)	5.5
233	2½-in. forging machine	Ajax (Old Tool)	7.5
234	1½-in. bolt header	Acme Machinery Co.	5.5
		Total	24

GROUP O. BLACKSMITH SHOP, BOLT SHOP—DRIVEN BY A 15 H. P. MOTOR.

No.	Tool.	Maker.	H. P.
237	2-in. triple head bolt cutter	Acme Machinery Co.	3
238	1½-in. triple head bolt cutter	Acme Machinery Co.	3
239	1½-in. triple head bolt cutter	Acme Machinery Co.	3
240	2½-in. double head bolt cutter	Acme Machinery Co.	3
241	Six-spindle nut tapper	Acme Machinery Co.	3
242	Six-spindle nut tapper	Acme Machinery Co.	3
		Total	18

GROUP P. BLACKSMITH SHOP, SPRING DEPARTMENT—DRIVEN BY A 15 H. P. MOTOR.

No.	Tool.	Maker.	H. P.
197	Large tapering rolls	John Evans' Sons	4
198	Combined nipper and trimmer machine	John Evans' Sons	4
199	Combined punch and shear	John Evans' Sons	4
		Total	12

GROUP Q. BLACKSMITH SHOP, HAMMERS—DRIVEN BY A 20 H. P. MOTOR.

No.	Tool.	Maker.	H. P.
109	200-lb. compact hammer	Bradley & Co.	8
110	200-lb. compact hammer	Bradley & Co.	8
111	200-lb. compact hammer	Bradley & Co.	8
112	200-lb. compact hammer	Bradley & Co.	8
113	50-lb. compact hammer	Bradley & Co.	5
		Total	37

E.—For Electric Lighting—Occasional, Day Load: (Estimated—Load factor and transmission efficiency, 75 per cent. total.)

	Arcs.	Incand'ts.	
Shops and shop yard	249	1,136	154.6 Kw.
Roundhouse and yard			
Transportation dept. yard		12	.4 Kw.
Total	249	1,148	155.0 Kw.

(Arc lamps estimated as requiring 600 watts each and incandescent lamps as requiring 50 watts each.)

Grand total .... 921.7 Kw.

This figure, 921.7 kilowatts (1,228.9 h.p.), which is the total *expected* power that will be demanded from the power plant under ordinary conditions of operation, is only about 5 per cent. more than the total rated full-load capacities of the generators, being well within their 25 per cent. overload capacity. The probable load that will be demanded will undoubtedly be within the combined capacity of the two larger 400-kw. generators, which can easily carry for their 25 per cent. overload capacity a steady load of 1,000 kw. (1,333.3 h.p.), so that the smaller 75-kw. dynamo may be held for reserve and for night service. The greatest possible total load that could be brought upon the power plant, by a simultaneous starting at full load of all the current-consuming devices upon the power and lighting systems, is about 1,880 kw. (2,507 h.p.), but this is a totally improbable and almost impossible combination.

METHOD OF APPLYING MOTOR DRIVES.

Neither the individual motor-drive nor the group-drive system was given absolute preference in the applications of electric motors for driving machine tools at the Collinwood shops. Individual direct-connected motors were installed on about three-eighths of the machine tools, while the remainder of the entire equipment was arranged for group driving from line-shafting, there being 17 groups, each having its line-shaft driven by a separate constant-speed motor. Rather than the method of driving by individual direct-connected motors hav-

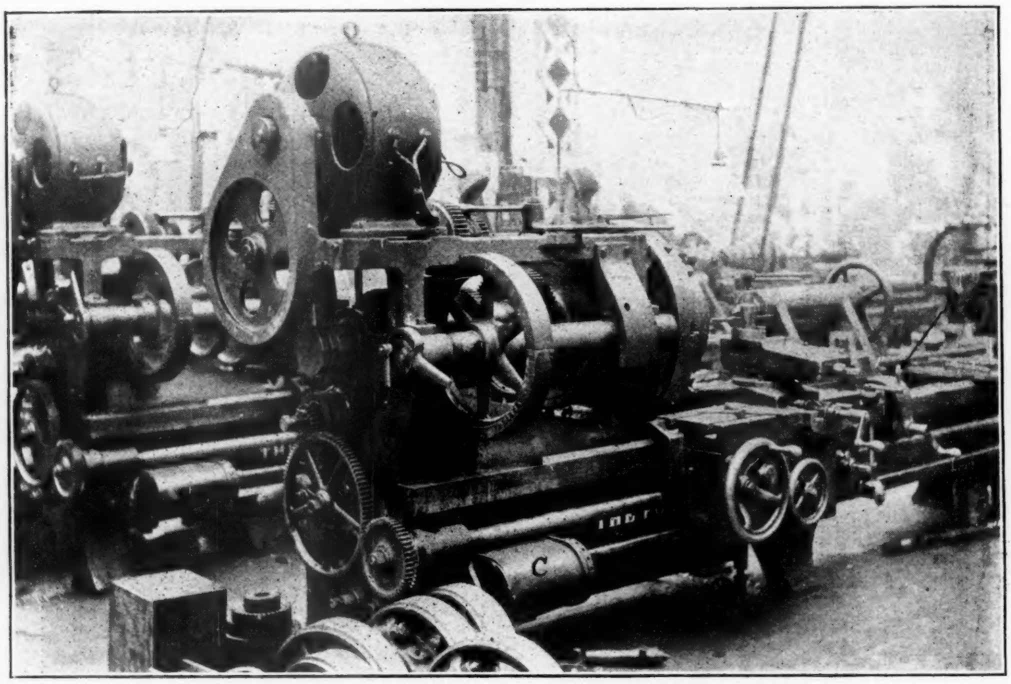
ing been considered the ideal condition to be resorted to exclusively, group-driving appears to have received the preference, inasmuch as tools were arranged for an individual drive only when the advantages to be gained thereby over a drive from line-shafting were of considerable weight.

One of the most important considerations favoring the application of individual direct-connected motors was that of the locations of the tools. It was very desirable and practically necessary that this method of driving be applied to all tools located in the portions of the shops served by traveling cranes, in order to prevent the interference that would otherwise be caused by belting, countershafting, etc., and also where the tools are scattered and isolated, as they are in the boiler shop, it was found to be cheapest and by far most convenient to apply individual drives. The latter is particularly evident when the losses of power that would have occurred in the necessarily long stretches of line-shafting are considered, and, moreover, because in the boiler shop it would practically have been necessary to have used one motor to each tool even if line-shafting had been used.

In general it may be said that the policy adhered to in the installation was that individual motor drives were applied to all machine tools which were of sufficient size so that the extra expense would be justified on account of the advantages to be gained from the variable speeds possible with them on the multiple-voltage system. It was thought desirable that machine tools requiring 5 horse-power, or over, should be so equipped to take advantage of the multiple-voltage system; this was done on all the larger machines with the exception of the quartering machine, some of the planers and shapers, and some of the boring mills, drills, grinders, etc. (tools Nos. 12, 15, 37, 38, 39, 42, 44, 45, 71, 72, 76, 82, 89 and 90—see tool list), which are individually driven by constant-speed motors on account of not requiring the variable speeds. The car wheel boring machine (tool No. 77) will probably be changed over for a multiple-voltage drive. The above-mentioned tools, equipped with constant speed motors, might have been group-driven from line-shafting, but for the fact that they are located in the heavy tool section of the machine shop, which has a traveling crane service. The tools that are individually driven by variable-speed motors include the heavier lathes (28-in. and over), the larger boring mills, the horizontal boring machine, the larger planers, frame slotter, wheel lathes, etc.

THE INDIVIDUAL MOTOR DRIVES.

In the application of the individual motor drives to the machine tools it was necessary to carefully consider not only the adaptation of the tool to the drive, but the electrical questions as well, including the method of speed control, the ranges of speed, etc., which were of great importance on account of their effect upon the former problem. As previously stated, the Crocker-Wheeler system of multiple-voltage speed control was, after a careful investigation of the various variable-speed systems, adopted and the necessary generating equipment for the four voltages installed as a part of the power plant equipment. The critical point which determines the practicability of this system is, however, the extent of the range of speeds to be made use of with the motors; because with too wide a range of speeds the sizes of the motors necessary become so large as to render the system too expensive and very inconvenient of application.



28-INCH TRIPLE GEARED ENGINE LATHE—POND MACHINE TOOL CO. DRIVEN BY 7½ H.P. MULTIPLE VOLTAGE CROCKER-WHEELER MOTOR.
COLLINWOOD SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

The multiple-voltage system permits of ranges of speed as wide as 6 to 1, and even up to 10 to 1; but if it were desired, with the wider ranges, to have the motors exert the same power at the lowest speeds as they would be required to with the highest speeds, they would necessarily have to be several sizes larger than necessary if only the higher speeds were to be used. This is due to the basic principle of the operation of dynamo-electrical machinery—that the capacity is almost exactly proportional to the speed at which the machine operates; so that the slower a motor runs the less is the power delivered with safety. If a motor on the multiple-voltage system be designed for the maximum power required with its slowest speed, then in delivering the same amount of power at speeds six or ten times greater it would be working at only one-sixth or one-tenth of its capacity, or, in other words, at the highest speeds the motor would be six or ten times too large. The objections to operating an electric motor at full load at one sixth or one-tenth of its full load capacity are its extremely low efficiency in the use of power at small loads, and the me-

conveniences (mechanical) resulting from the use of a machine many times too large, such as difficulty of supporting the extra weight, vibration and momentum of the heavier rotating parts, etc., as well as the greater expense of installing a large equipment.

In view of these objections to the wide speed range, a small range of speed variation, namely, 2.4:1, was adopted for the motors; this removes almost entirely the objections to the wider ranges by permitting the use of motors from one-half to one-third of the sizes that would have been required to obtain full power through the 6 to 1 or 10 to 1 ranges, and, still, the possibility of using the motors tnrough ranges of 6:1 or 10:1, when on light work, is retained. At the same time, all the advantages of the wider ranges have been retained by the applications of "back gear" attachments in the motors' drives, which multiply as many times as necessary the speed range at full power obtained from the motor.

In many cases these runs of gearing have been so chosen that the actual ranges of speeds possible at the tool are from 50 to 1, or even 100 to 1. On the individually-driven lathes three changes of gearing are provided in all, in addition to the lathe's back gears, while on the boring mills two changes were found to be sufficient.

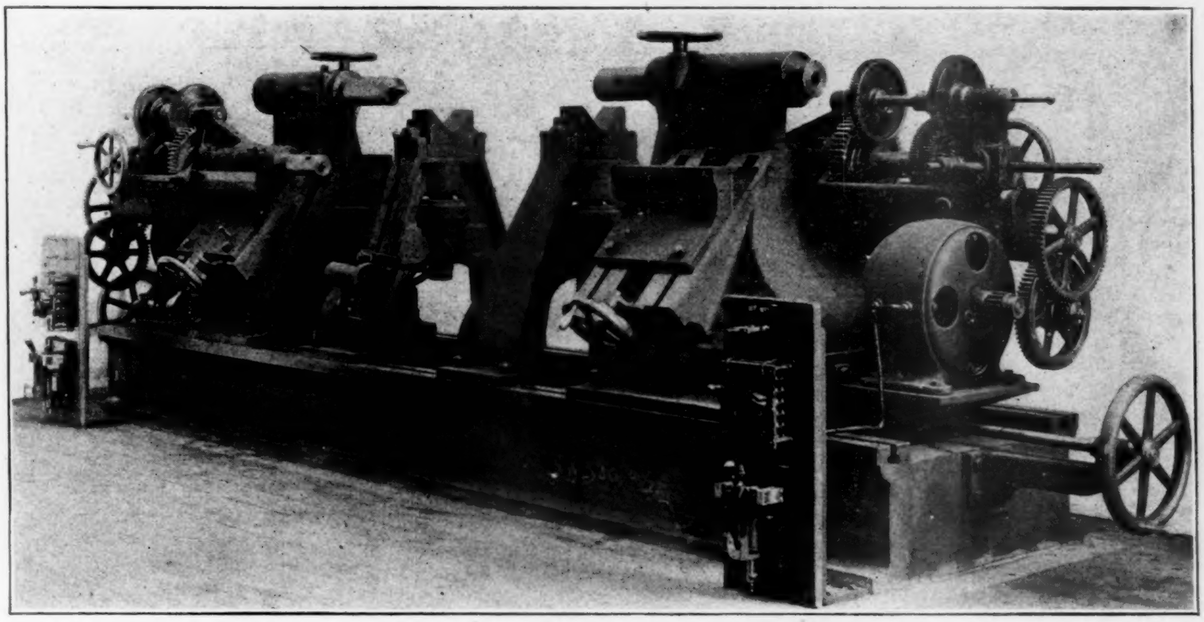
The adaptations of the tools to the conditions imposed by the electric drives were left mainly to the tool builders themselves to decide, as a result of which there are, on different tools, several different methods in use for attaining the desired results. In nearly every case the motor has been mounted on brackets attached to the frame of the machine, and connected to the driving mechanism through as many alternative trains of gearing as the case has required. The method of connecting through any desired one of these trains varies; in a number of cases it is done by sliding change-gears in aud out of mesh along a splined shaft, in other cases the different gears are picked up by means of clutches, while in still others sliding keys or drop keys are used. Also in some cases the operation of changing the gear ratios is made convenient and simple by levers so arranged as to connect up the different series by the positions to which it is moved; an example of this appears in the 16-in. Niles slotter illustrated on page 47. These, as well as the types of brackets and framing, illustrate the ideas of the different tool builders, and experience only will indicate the advantages of the several methods and point out the direction of possible improvements.

The controlling devices have, in some cases, been mounted on stands attached to the floor and near the workman's hand. On the lathes the controllers are mounted on the bed underneath the headstock, and are operated through mechanical connections by a handle attached to the lathe carriage, and therefore always convenient at whatever point along the bed the tools may be working. The convenience of control thus obtained lends itself in the highest degree to self-education on the part of the workman in obtaining, at all times, that cutting speed which will give the best results with each particular piece of work, and so tends to increase of output.

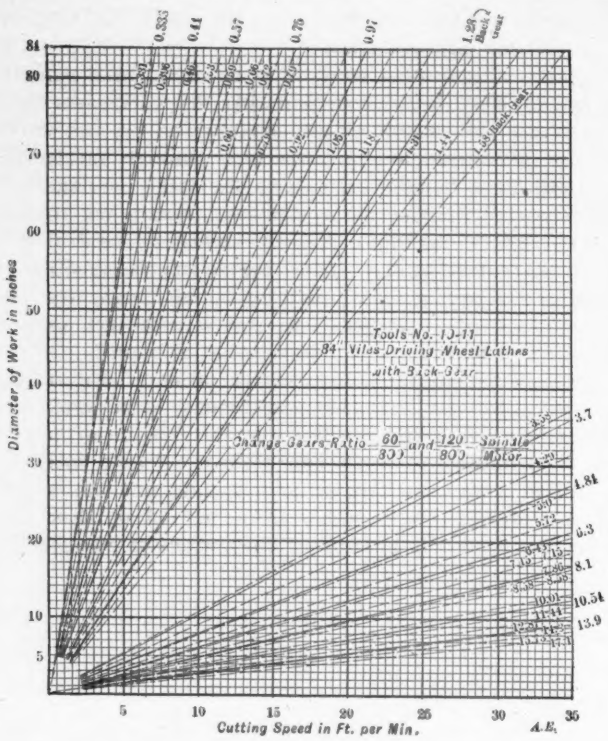
In the determinations of the correct ratios of the various change gears for the back gear attachments to be applied to the machine tools, a diagram showing the relation of cutting speeds to diameters of work was plotted for each tool; the diameters of work were laid off as ordinates and the cutting speeds as abscissæ. Then vector lines, laid off on these diagrams corresponding to numbers of revolutions of the spindles, present graphically the relations between the cutting speeds and the diameters of work for those spindle speeds. Examples of such initial diagrams for the 84-in. Niles driving wheel lathes and the 28-in. Pond engine lathes are presented on page 46. As may be seen, the spindle speed for each vector is named upon it in rev. per min., the smaller number of full lines indicating the various spindle speeds possible with belt drives and cone pulleys, while the dotted lines indicate the greater range of speeds available with the multiple-voltage system.

Where the variation in the number of revolutions at the spindle of a tool required to give the correct cutting speed over the range of diameters of work to be handled does not exceed 2.4 to 1 no change gears are necessary, as that variation can be taken care of by the multiple-voltage system of control and the full 6:1, or 10:1, range at reduced power can be used for variations in cutting speed only.

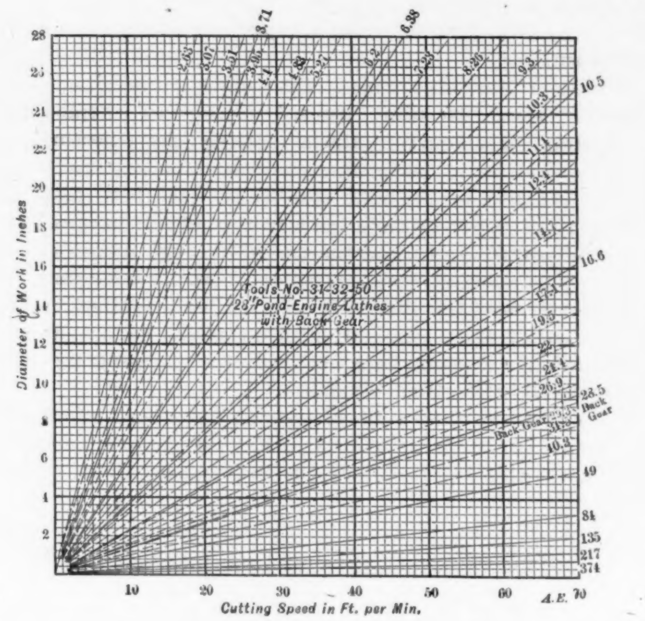
Where this ratio exceeds 2.4 to 1, a second gear ratio diagram was prepared, having revolutions per minute as abscissæ, and gear ratios as ordinates; diagonal lines were drawn on these diagrams to represent the various voltages available with the multiple-voltage system, and the intersections of these lines



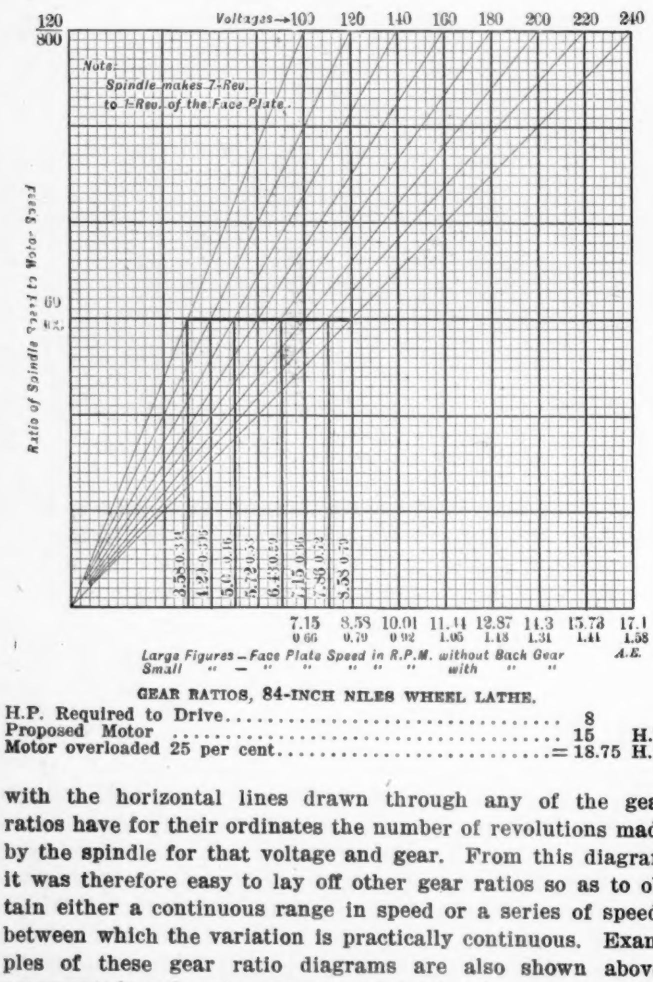
84-INCH QUARTERING MACHINE.—NILES TOOL WORKS CO.
EACH HEAD DRIVEN BY A 5-H.P. CONSTANT-SPEED CROCKER-WHEELER MOTOR.
COLLINWOOD SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.



84-INCH NILES DRIVING-WHEEL LATHES WITH BACK GEARS.

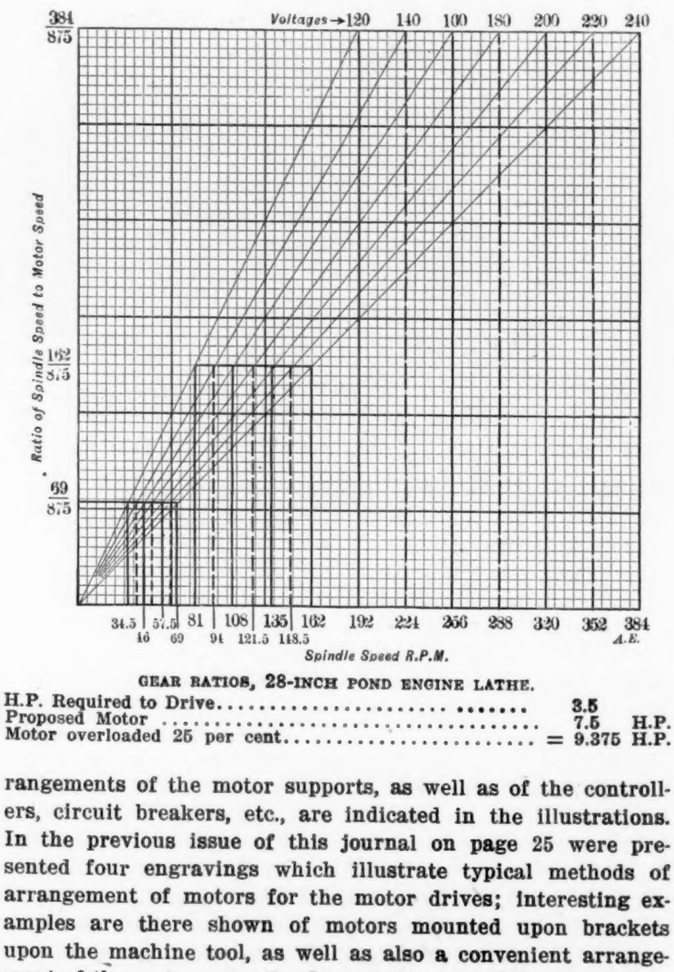


28-INCH POND ENGINE LATHES WITH BACK GEARS.



GEAR RATIOS, 84-INCH NILES WHEEL LATHE.

H.P. Required to Drive	8	
Proposed Motor	15	H.P.
Motor overloaded 25 per cent	= 18.75	H.P.



GEAR RATIOS, 28-INCH POND ENGINE LATHE.

H.P. Required to Drive	3.5	
Proposed Motor	7.5	H.P.
Motor overloaded 25 per cent	= 9.375	H.P.

with the horizontal lines drawn through any of the gear ratios have for their ordinates the number of revolutions made by the spindle for that voltage and gear. From this diagram it was therefore easy to lay off other gear ratios so as to obtain either a continuous range in speed or a series of speeds between which the variation is practically continuous. Examples of these gear ratio diagrams are also shown above, accompanying the above-mentioned initial diagrams for the wheel lathes and engine lathes, all of which required speed ranges greater than 2.4 to 1.

In the following descriptions of the machine tools the arrangements of the motor supports, as well as of the controllers, circuit breakers, etc., are indicated in the illustrations. In the previous issue of this journal on page 25 were presented four engravings which illustrate typical methods of arrangement of motors for the motor drives; interesting examples are there shown of motors mounted upon brackets upon the machine tool, as well as also a convenient arrangement of the motor upon the floor at the rear of the machine.

TOOLS.

On pages 44-46 are illustrated several tools which are representative examples of the motor applications for driving. The

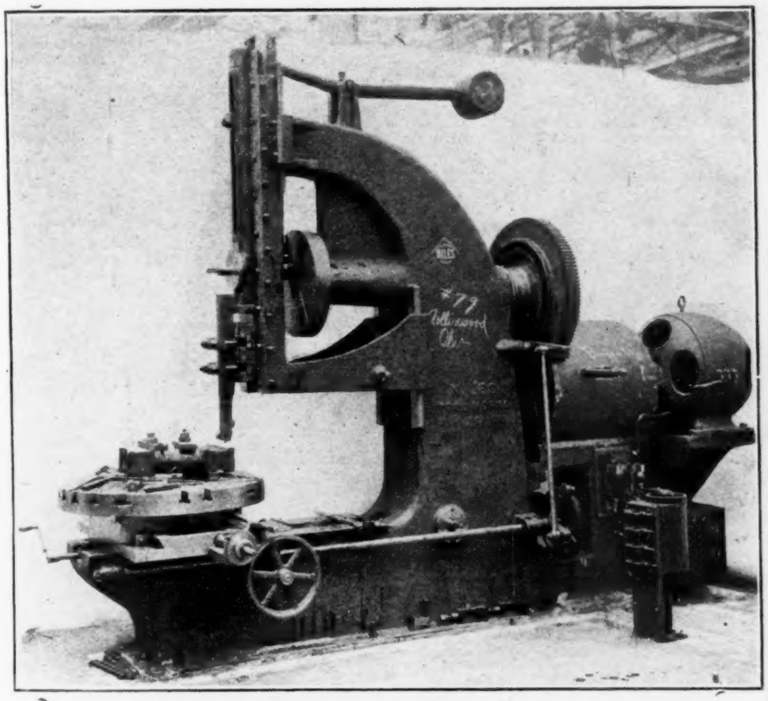
motor-driven lathe presents advanced ideas of electric driving, the motor being mounted directly upon framework above the headstock and gear connected to the drive. This lathe is a 28-in. triple-geared lathe built by the Pond Machine Tool Company, Plainfield, N. J., and specially adapted for the motor, which is a 7½ h.-p. Crocker-Wheeler multipolar motor. Twelve different speeds are available from the multiple voltage system and by means of gearing and clutches three gear ratios are possible, making a wide range of 36 speeds possible. The most remarkable feature of the electrical application is the location of the controller, as shown at C, so that it can be at all times manipulated from the carriage by handle, H, through the agency of a splined shaft parallel to the lead screw.

This lathe has a bed 10½ ft. long, and will take work, swinging 29½ ins. over the bed, or 22 ins. over the carriage, 4 ft. between centers. The bed is heavy and wide enough to prevent overhang of carriage at the front when turning on the largest diameters. The carriage has long bearings upon the ways, is gibbed down to the bed for stability and can be clamped rigid when cross-feeding. A desirable feature is that when either of the feeds or the screw-cutting attachment of the carriage is in use the others are all locked.

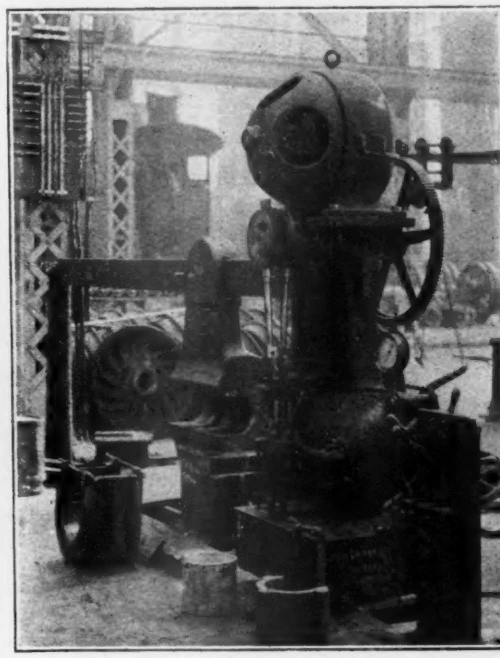
The slotting machine shown above is a 16-in. crank-motion slotter direct driven by a motor through the medium of gearing and clutches. The clutches control the various gear ratios for the drive, which may be changed from one to another by means of the handle projecting from the gear case. This slotter has a crank-driven ram and is equipped with a Whitworth quick-return motion. The feeds are actuated by a large cam on the main gear, and always take place at the top of the stroke. This machine has a 36-in. table, with a 36-in. longitudinal and 24-in. cross-feed, and has a circular feed. The maximum height of the ram above the table is 19 ins. The extremely convenient location of the controller and circuit breaker is made evident in the engraving.

The 84-in. Niles quartering machine, illustrated on page 45, has two constant-speed drives, each Crocker-Wheeler 5 h.-p. multipolar motors, one of which is located at each head of the machine, entirely independent of the other. Each motor has its controller and circuit breaker located conveniently on a stand in front of it. This machine will quarter wheels from 45 to 84 ins. in diameter for crank radii of from 8 to 16 ins. The boring spindles may be changed to either side of their heads at will for boring right or left-hand leads. The steady rests between the heads are to carry the weight of the wheels, the centering spindles acting merely to assist in locating them.

The remaining engravings on this page illustrate the application of the motor drive to a 200-ton, 48-in. hydrostatic wheel press, built by the Niles Tool Works. The motor, which is a 10 h.-p. multiple-voltage Crocker-Wheeler motor, is geared direct through a single-reduction to the eccentric shaft from which the pumps are actuated. This is an excellent example of the compactness and simplicity offered by the motor drive.



16-INCH CRANK-MOTION SLOTTER.—NILES TOOL WORKS.
DRIVEN BY MULTIPLE-VOLTAGE CROCKER-WHEELER MOTOR.



200-TON NILES WHEEL PRESS.
DRIVEN BY 10-H.P. CONSTANT-SPEED MOTOR.

COLLINWOOD SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

Mr. E. B. Thompson has been appointed master mechanic of the Iowa & Minnesota division of the Chicago & Northwestern Railway with headquarters at Mason City, Iowa, to succeed Mr. E. W. Pratt, who has been transferred to the Fremont, Elkhorn & Missouri Valley. Mr. Thompson has for a number of years held the position of mechanical engineer of this road at the motive power headquarters in Chicago.

Mr. James McNaughton, general superintendent of the Brooks Works of the American Locomotive Company at Dunkirk, N. Y., has been appointed to succeed Mr. J. F. Deems as general superintendent of the Schenectady works, in addition to his duties at Dunkirk. Mr. McNaughton has been in responsible charge of the Dunkirk plant since 1898, when he resigned from the position of superintendent of motive power of the Wisconsin Central, which he held for eight years. Mr. W. L. Reid has been promoted to the position of superintendent of the new works at Schenectady, and Mr. R. H. Gilmour, formerly superintendent of the Camdem Foundry Company of Toronto, has been appointed superintendent of the Brooks plant.

NEW FREIGHT LOCOMOTIVE FOR THE "BURLINGTON."

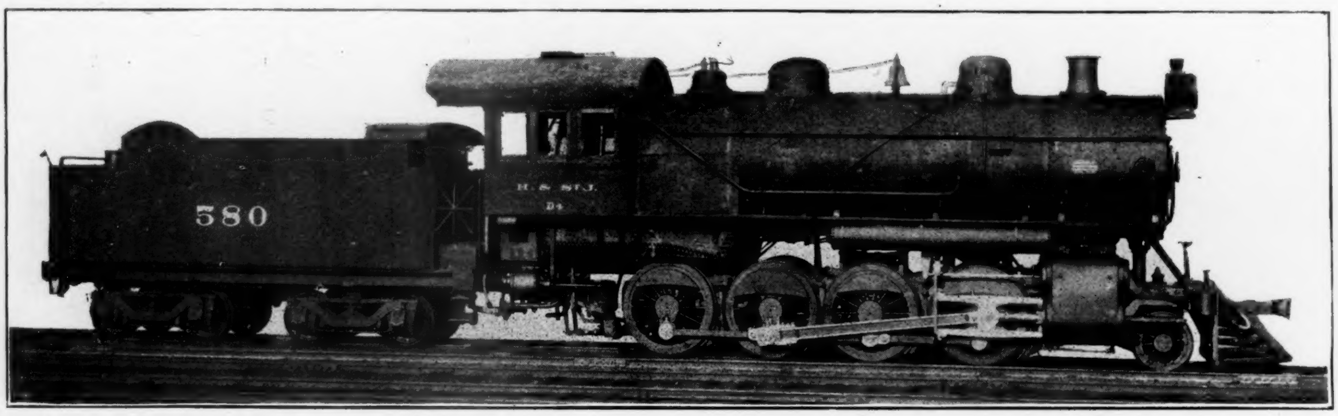
2—8—0 TYPE.

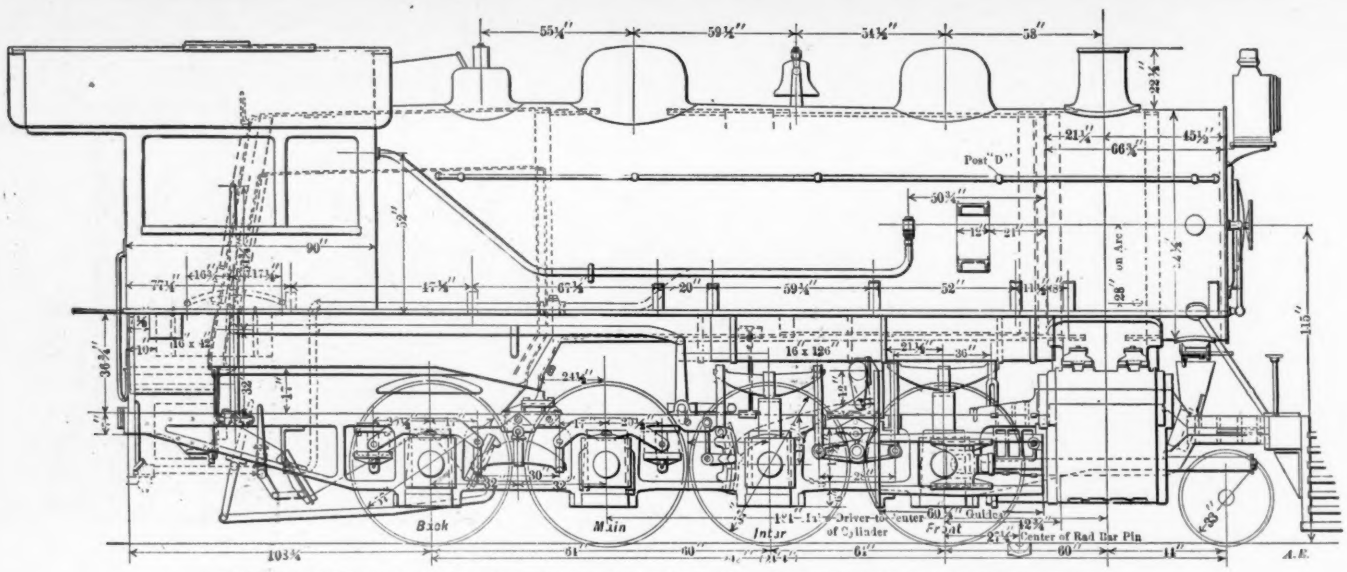
BUILT BY THE AMERICAN LOCOMOTIVE COMPANY.

SCHENECTADY WORKS.

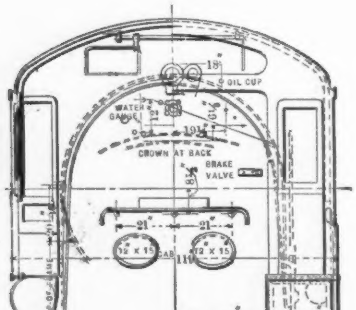
This is the heaviest locomotive ever built for the Burlington, and as this road has been conservative in the matter of increased weight and power the advent of this design is notable. When the engine of this type was built for the Burlington & Missouri River Railroad in 1898 (AMERICAN ENGINEER, September, 1898, page 296) by the Pittsburgh Locomotive Works it was regarded as a heavy engine, but the present class, for the Hannibal & St. Joe Railroad, part of the same system, is a long step in advance. The comparison of a few details will show this:

	1898.	1903.
Total weight (pounds)	181,200	207,900
Weight on drivers (pounds)	166,000	181,000
Heating surface (square feet)	2,675	3,827
Grate area (square feet)	31.6	54
Tractive power (pounds)	39,300	42,500





HEAVY FREIGHT LOCOMOTIVE FOR THE BURLINGTON.—AMERICAN LOCOMOTIVE COMPANY, BUILDERS.



VIEW OF FIREBOX AND CAB.

The total weight has increased 14.6 per cent., the heating surface 43 per cent., and the tractive power 8 per cent. This is an example of systematic progress, indicating the trend of locomotive design toward increasing power along reasonable and conservative lines. Attention will be directed to a number of interesting details of the design of this engine in another article. The following ratios and list of dimensions are worthy of record:

RATIOS.

Tractive power = ... 42,500 lbs.

(1) $\frac{\text{Heating surface}}{\text{Cylinder volume}}$ = ... 310.6

(2) $\frac{\text{Tractive weight}}{\text{Heating surface}}$ = ... 47.3

(3) $\frac{\text{Tractive weight}}{\text{Tractive effort}}$ = ... 4.26

(4) $\frac{\text{Tractive effort}}{\text{Heating surface}}$ = ... 11

(5) $\frac{\text{Heating surface}}{\text{Grate area}}$ = ... 71.7

(6) $\frac{\text{Tractive effort} \times \text{diameter drivers}}{\text{Heating surface}}$ = ... 627

(7) Heating surface in per cent. of tractive power = ... 9%

FREIGHT LOCOMOTIVE—C., B. & Q. RAILWAY.

2—8—0 TYPE.

General Dimensions.

Fuel	Bituminous coal
Weight in working order	207,900 lbs.
Weight on drivers	181,000 lbs.
Weight engine and tender in working order	320,100 lbs.
Wheel base, driving	15 ft. 8 ins.
Wheel base, rigid	15 ft. 8 ins.
Wheel base, total	24 ft. 4 ins.
Wheel base, total, engine and tender	55 ft. 2¼ ins.

Cylinders.

Diameter of cylinders	22 ins.
Stroke of piston	28 ins.
Horizontal thickness of piston	5½ ins.
Diameter of piston rod	4 ins.

Valves.

Kind of slide valves	Piston type
Greatest travel of slide valves	6 ins.
Outside lap of slide valves	1 in.
Inside clearance of slide valves	⅛ in.
Lead of valves in full gear,	Line and line at front, with ¼-in. lead at one-quarter cut-off
Transmission bar	With

Wheels, Etc.

Number of driving wheels	8
Diameter of driving wheels outside of tire	57 ins.
Thickness of tire	3½ ins.
Driving box material	Main, cast steel; others, steeled cast iron
Diameter and length of driving journals,	9½ ins. and 9 ins. diameter x 12 ins.
Diameter and length of main crankpin journals,	(Main side, 7¾ ins. x 4¾ ins.) 7 ins. diameter x 7 ins.
Diameter and length of side-rod crankpin journals,	(Intermediate, 5¾ ins. x 4½ ins.) 5½ ins. diameter x 3¾ ins.
Engine truck, kind	Two-wheel, swing bolster
Engine truck, journals	6 ins. diameter x 10 ins.
Diameter of engine truck wheels	33 ins.
Kind of engine truck wheels	Cast-iron spoke center, with 2½-in. tire

Boiler.

Style	Straight
Outside diameter of first ring	78 ins.
Working pressure	210 lbs.
Material of barrel and outside of firebox	Steel
Thickness of plates in barrel and outside of firebox,	9-16 in., ⅝ in., ¾ in., 13-16 in., ⅞ in. and 1 in.
Firebox, length	108 ins.
Firebox, width	72¼ ins.
Firebox, depth	Front, 79¼ ins.; back, 68½ ins.
Firebox, material	Steel
Firebox plates, thickness:	Sides, ⅜ in.; back, ⅜ in.; crown, ⅜ in.; tube sheet, 9-16 in.
Firebox, water space	Front, 4½ ins.; sides, 4½ ins.; back, 4½ ins.
Firebox, crown staying	Radial
Tubes, number	462
Tubes, diameter	2 ins.
Tubes, length over tube sheets	15 ft.
Firebrick, supported on	Water tubes
Heating surface, tubes	3,605.8 sq. ft.
Heating surface, water tubes	26.71 sq. ft.
Heating surface, firebox	195.06 sq. ft.
Heating surface, total	3,827.57 sq. ft.
Grate surface	54.21 sq. ft.
Exhaust pipes	Single
Exhaust nozzles	5½ ins., 5¾ ins. and 6 ins. diameter
Smokestack, inside diameter	16 ins.
Smokestack, top above rail	15 ft.

Tender.

Weight, empty	42,200 lbs.
Wheels, number	8
Wheels, diameter	33 ins.
Journals, diameter and length	5 ins. diameter x 9 ins.
Wheel base	16 ft. 10 ins.
Tender frame	Wood, with center sills of steel
Water capacity	6,000 U. S. gals.
Coal capacity	12 tons

The United States Geological Survey is at work on a new map of the Grand Canyon of Arizona. Considerable progress has been made. Some of the lines of sight between triangulation stations are 70 miles long, and as observations can only be made to good advantage between sunrise and 9 A. M. or between 4 P. M. and sunset the work is necessarily slow. The signals flash an easily deciphered light only an inch square as far as from Kendrick Peak to Point Sublime, a distance of 68 miles. Accurate elevations have been established on the Bright Angel trail, and it is no longer necessary to guess how high one is above sea level. It is now known that from the rim of the south wall to the river is a drop of 4,430 ft. at Bright Angel and 4,913 ft. at Grand View, while from the north rim the distance is several hundred feet greater, or more than a mile. Twenty buildings like the Masonic Temple, Chicago, could be superimposed in the deepest gorge of the Grand Canyon without reaching the top.

THE NEW ROUNDHOUSE AT RENSSELAER.

NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

HEATING AND LIGHTING SYSTEMS.

This roundhouse has 30 stalls, and will have 50 when increased facilities are required at this point. The extension is shown in dotted lines in the plan. In selecting the engravings an effort was made to include as much information as possible in the illustrations. The equipment includes shops, storehouse, oilroom, office, rest-room, boiler-room, and facilities for handling coal and ashes. The heating system is especially interesting, this being one of the best equipped roundhouses in this respect ever built. It is also very well lighted.

The fans draw air through heater coils and deliver it into underground ducts at the outer wall of the building. These ducts decrease in cross-sectional area, as indicated in the engravings, in order to secure uniform delivery at the pits which are most remote from the fans. Each pit opening has a thimble and damper, and the locations of the delivery of heated air against the engines and tenders are shown in the plan. Instead of following their usual practice, the contractors, the B. F. Sturtevant Company, provided unusually large heating surfaces and ample fan capacity, with a view to ventilating as well as heating the building.

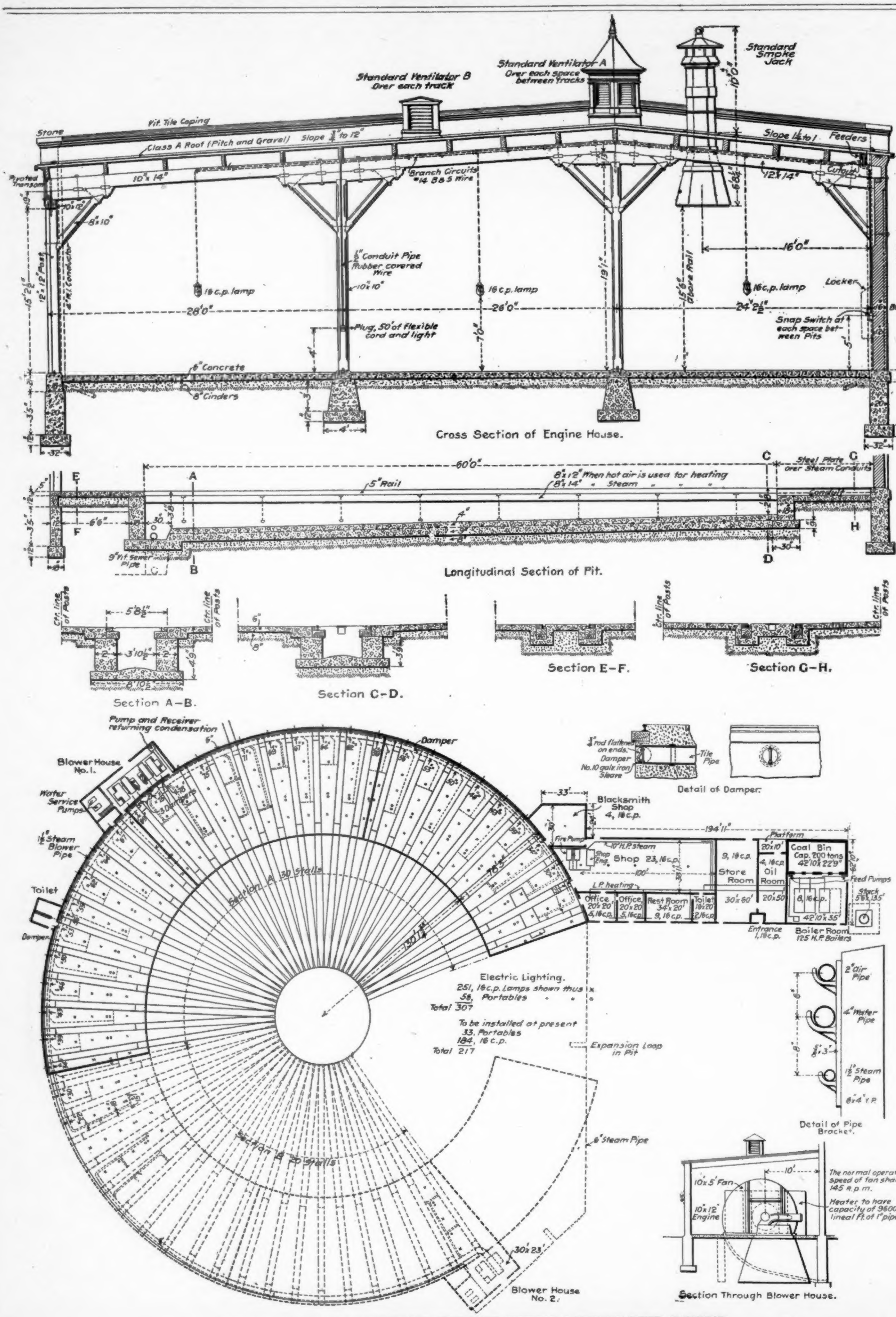
For convenience, the following information is arranged in a table:

Fans, type	Three-quarters housing
Fans diameter	10 ft.
Fans, width of housing	5 ft.
Engines, cylinders	10 by 12 ins
Engines, nominal horse-power	32
Fan discharge (each fan)—	
At 140 revs. per min.	62,000 cu. ft. per min.
At 160 revs. per min.	70,000 cu. ft. per min.
Cubical contents of 30 stalls	847,600 cu. ft.
Air changed, normally	Eight times per hour
Area inlet, each fan	4,320 sq. in.
Velocity at inlet	2,333 ft. per min.
Combined area of outlets	10,856 sq. in.
Velocity at outlets	933 ft. per min.
Pressure at inlet	¼ oz.
Pressure at outlets	Less than ⅛ oz.
Heater piping, each fan	11,080 ft., 1-in. pipe
Steam pressure for engines	80 lbs.
Steam pressure for heaters—live steam	10 lbs.
Heating surface (exterior) of 22,160 ft. of 1-in. pipe	7,641 sq. ft.
Volume of building per square foot of total pipe heating surface,	111 cu. ft.

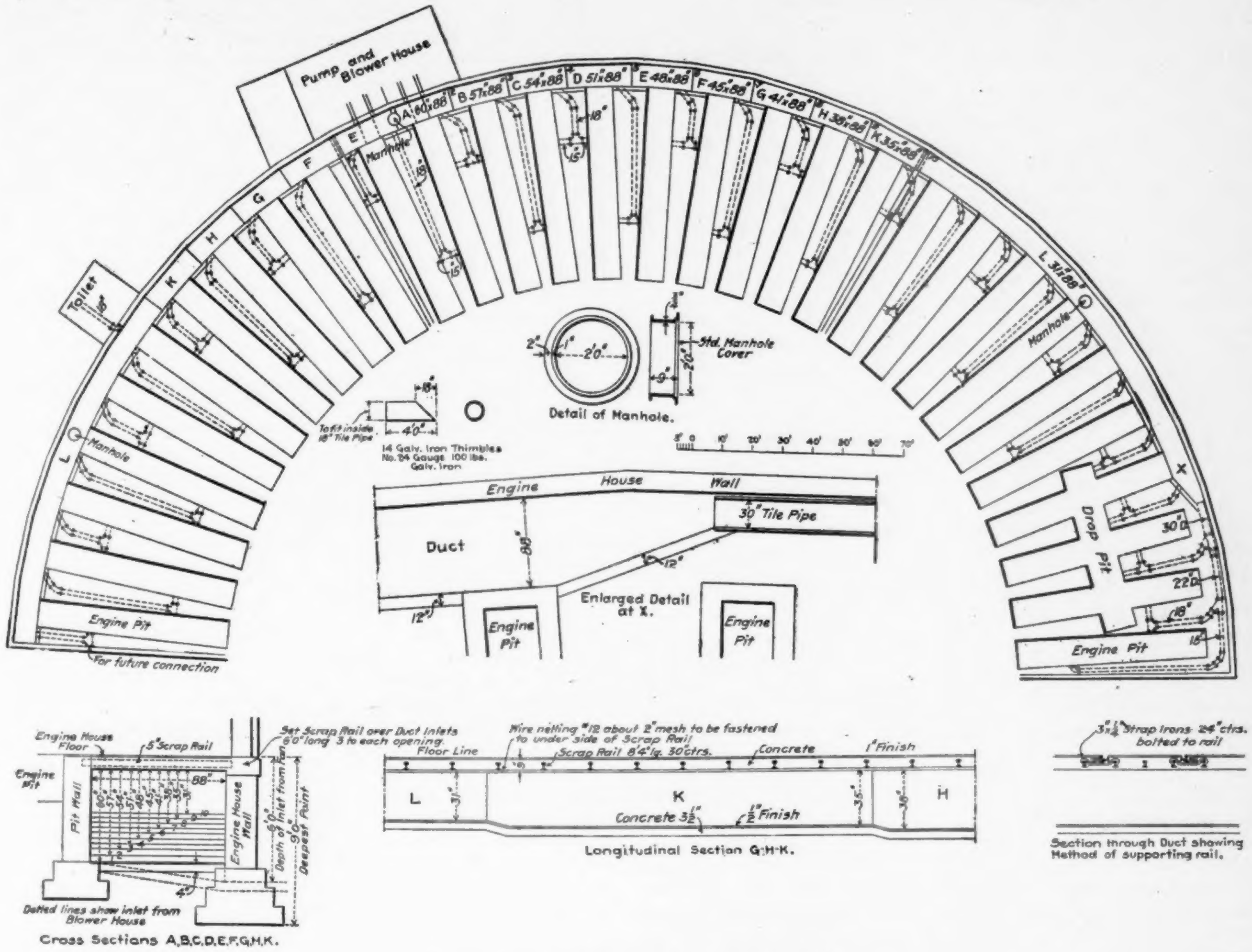
Each heater consists of two groups of five sections of four rows each, containing 11,080 linear feet of 1-in. pipe, exclusive of the fittings. Two of these sections are arranged to receive the exhaust of the fan engines and two water-service pumps, also of the receiver pump, which are placed in the fanhouse, and the other sections use live steam piped around the house from the boiler-room. The inlet to the first two and the last three sections of the heater groups are separated by blank flanges, so that either two, three or five sections may be heated independently. The contractors guarantee the heaters to warm all parts of the building to a uniform temperature of 65 degs. when the outside temperature is at zero. Tests have not yet been made, but the guarantee is believed to be fully and amply met. Air from the building or from out of doors may be taken through the heaters, as desired. Roof ventilators and wooden smoke jacks are arranged as indicated in the drawings. This installation sets a high standard in the heating and ventilation of roundhouses.

The shops and offices are heated by live steam from the boilers, the pressure being reduced by a reducing valve at the boiler header. The radiators provide 1 sq. ft. of radiating surface for 80 cu. ft. of space in the various rooms, the pipe coils being of 1½-in. pipe. Steam is supplied by three water-tube boilers of 125 h. p. each, furnished by the Franklin Boiler Works Company, of Troy, N. Y. The stack is of steel plate, 135 ft. high, and of the self-sustained type. This construction and other interesting standards of roundhouse construction on this road will be presented in another article.

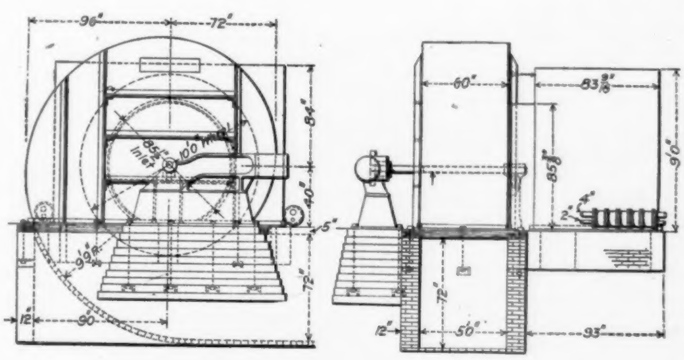
The standard method of roundhouse lighting of this road is



NEW ROUNDHOUSE AT RENSSELAER, NEW YORK CENTRAL & HUDSON RIVER RAILROAD.



ARRANGEMENT OF HEATING DUCTS AND DELIVERIES.



ONE OF THE FAN HEATER UNITS.

used in this installation. In the spaces between pits are three 16 candle-power pendant lamps, and at each pit is a plug on one of the posts, to which a portable lamp may be connected for use under engines. On the outer wall at each space is a four-point snap switch. The first point controls the lamp at the pilot ends of the engines; the second point controls the other two pendant lamps, and the plug is in circuit at all times. This plan lights the passage around the house without requiring all the lamps to be lighted. The lamps are in two-wire circuits from three-wire alternating-current feeders, the voltage of the lamps being 110. Special care was taken in the construction of the flexible cords, and the lamps are protected by aluminum cages. Current for lighting is taken from the feeders of the Albany and Hudson Railway and Power Company.

The design and construction of the heating and lighting were carried out by Mr. Edwin B. Katte, mechanical engineer, under the direction of Mr. W. J. Wilgus, chief engineer of the road.

Agitation of the passenger-transportation problem in New York City has led to several sensible suggestions for relief from crowding, but the root of the matter has not yet been reached. It is wise to extend third tracks and separate long and short distance travel. It is necessary to have a sufficient number of cars, and obviously, enough trains must be run. All of these things are perfectly clear even to the office boy of a railroad officer, and such conclusions should not require several lengthy sessions of a body of the dignity of the railroad commission of a great State. When these improvements have been made, there yet remains the most serious difficulty—that of getting passengers into and out of the cars quickly. It appears that the primitive construction of cars with end doors, swinging gates, and narrow passages for entering and leaving, has not been brought to the attention of the investigators. To the suggested improvements should be added a lesson from the method of the Illinois Central in handling the crowds at the Chicago World's Fair, which stands to this time as the most successful transportation of large crowds of passengers. The New York situation requires the application of the principles of that method. We shall have more to say upon this subject.

CORRESPONDENCE.

THIRTY-TON BOX CAR WITH STEEL UNDERFRAME.

To the Editor:

In your January issue there appears among the many good things a description of a box car of composite type of construction, differing from the old practice in the substituting of steel sills of channel section for those of wood. Since an invitation is extended to criticise this car, the conclusion is a reasonable one that somebody will ask the why and wherefore of certain features of design.

There is considerable original thought in this design, but the question presents itself as to why the channel sills in connection with intermediate sills and truss-rods should be used, if reduction of dead weight was a desideratum, as calculation seems to show that there is a difference of over 700 lbs. in favor of six wooden sills and four 1⅜-in. truss-rods. The four truss-rods would be subjected to a unit stress of about 9,000 lbs., with no aid whatever from the sills, while the two 1⅝-in. rods would have less work to do, since the channel sills would carry a certain percentage of the load and thus relieve the rods to that extent. Under these conditions, would it not have been a better construction to use pressed steel sills of a fish-belly section without rods, and of such a depth as to give a correct resisting moment for the load? If weight restrictions stand in the way, this construction, as well as the wooden sills, point the way to a solution of the problem, and allows some metal to be put in the bolsters, where it is too often needed. The arrangement of the truss-rods in this car could not be improved on greatly, as they are disposed so as to deposit their loads on the bolsters near the center sills and thus give a minimum bending moment on the bolsters; and a further evidence that the designer knew the triangle of forces is shown in the location of the crossties so as to have a short diagonal length in the truss-rods—an arrangement which will produce the lowest tensile stress in the rods. The center sills are latticed on the top, so says the description: at this I marvel, for the center sills cannot be in the best condition to resist the compression stresses due to the horizontal component of the truss-rod load, without being latticed on both top and bottom sides. If this proposition holds for static loads, what about buffing strains, which are believed to range from 100,000 to 300,000 lbs., if a report to the Western Railway Club on tests made with the Westinghouse Dynamometer car by the Lake Shore Railway is entitled to credence.

A further examination of the details of this car would seem to show a weak body bolster, which is of the double plate type, consisting of a top and bottom member, both of which are ½ in. thick by 12 ins. wide, between which is a ½ x 5-in. plate extending from the top of the center sills to the lower plate of the bolster at a point just above the side bearings. The function of this narrow plate being apparently that of a strut to receive the thrust of the side bearings, although it does afford a certain relief to the tension in the upper plate of the bolster. To say or think a thing is weak carries no weight if proof is not added to substantiate the position.

The test of the pencil, based on an assumed light weight of car at 32,000 lbs., minus trucks at 6,000 lbs. each, gives, with the 60,000 lbs. rated capacity of the car, a load of 80,000 lbs. to be sustained by the bolsters.

Assuming again—and these figures are necessarily assumptions, since no weight is given—that the light weight is correct and that the load is uniformly distributed on one half the bolster, we have 8,521 lbs. uniformly distributed load, in addition to which there is a concentrated load of 9,040 lbs. deposited on the bolster by one truss-rod. These loads produce a combined bending moment of 237,735 in.-lbs. with a resulting tensile unit stress of about 8,000 lbs. in the upper plate of the bolster, which would be safe if backed by a lower plate of proper rigidity, but the lower plate has a danger zone between the side bearing and lower flange of the center sills, for a distance of practically 18 ins., and this ½-in. lower member is therefore subjected to a compression unit stress of 8,780 lbs. Authorities on strength of materials tell us that the greatest safe load in compression for a column of steel of about 70,000 tensile strength should not exceed 7,000 lbs. for a ratio of $l \div r$, in which $l =$ length of column and $r =$ least radius of gyration—the column supposed to have fixed ends. Calculated on this basis, the bolsters would scarcely carry their static load free from the side bearings. Perhaps that was the intent of the designer; if so, investigation of the problem would be "love's labor lost"; but it will not be out of place to say that many good designers have aimed to produce a bolster that would stand alone and thus decrease curve resistance, always seeking to reduce dead weight in any other detail of a car rather than have a weak bolster.

There are some novel things about this car, but the thought presents itself that if steel is a good thing—and no one will say that it is not—in the under-framing, why not follow out the metal idea to its logical conclusion and build a standard steel box car, as is now looked upon favorably by many progressive car designers. It is to be hoped that sufficient force of opinion will be brought to bear in this question to soon break through the hard shell of conservatism in which it has been too long enveloped.

O. H. REYNOLDS.

To the Editor:

With regard to the 30-ton box car designed by Mr. George I. King and illustrated in the January number of the AMERICAN ENGINEER AND RAILROAD JOURNAL, I wish to submit the following:

Structural steel underframing has been considered many times with a view of having one design answer for the various types of freight cars. This is a very good scheme, and would probably serve some roads very well, where they wished to have the fewest possible number of different designs and, consequently, have to carry the least number of different parts in stock, being at the same time those of a standard section which can easily be secured on the market. One other good feature of standard sections is that there need be no unnecessary delay in getting material for the construction of these cars, as no special machines are required in preparing material or constructing them in any car works. They can very easily be constructed in the car shops of any railroad; hence the ease with which the car may not only be constructed but repaired. The best feature in the construction where truss-rods are used is a minimum weight of car for the load carried. If all of these goods points are to be maintained without serious weakness entering into the construction, we will have attained a good purpose.

Considering the steel underframe shown in the January issue of your journal, the weakest point of this design is the body bolster. It is not rigid enough to transfer the load of the side sills to the center plate. The lower member of the bolster is brought up to the upper member as it leaves the center sill. While it may be necessary to do this to provide clearance below the bolster, and is allowable to some extent, and yet maintain sufficient strength, in this construction we have only the resistance of two ½-in. x 12-in. plates to sustain the load on the side sills. Probably a better construction would be to carry the lower member horizontally from the center sill to the side sill, or as nearly horizontal as allowable for clearance. It would then be necessary to stiffen the lower member to prevent buckling; this could be done by bolting the two plates together above the side bearing, using a distance piece or ferrule between the upper and lower members.

The manner of securing the ends of the truss-rods to the bolster is a little weak. While the size of the rivets is not given, it would be necessary to use two ⅞-in. rivets; even then this would not be a secure fastening, as the rivets might tear through either the plate or strap, or the heads might snap off. A better way to secure these straps would be to rivet them on the top of the bolster instead of on the bottom.

The gusset plates at the end of the frame, which are turned up to act as stops for the end of the car body, would constitute a good arrangement, provided it were possible to hold the body down tight against the gusset plates. As this is impossible, it would be only a short time before these plates would be battered out, allowing the end of the car to follow. A shifting load would bring this about very rapidly. It would be best to have cast pockets for the bases of the end posts and braces. The pockets could be well fastened to the sills, thus preventing the ends from bulging out, and they would also strengthen the end of the car body laterally.

If we consider the corner of the frame, as regards strength for poling, we find that we can depend only on the side sill and diagonal angle. The light end sill, which is a ¼-in. pressed "Z" bar, will not be in service long before its properties as a compression member will have been destroyed. If the angle brace becomes the least amount bent, it cannot be depended on, so we have only the side sill left. When poling with a heavy engine, and the pole is at an angle greater than 45 degs. with the center line of the car, and any of the members are distorted, we probably would find that

the safe stress limit would be exceeded in the members. A better construction for the corner would be to replace the present end sill with one much heavier, and run the diagonal brace from the gusset plate at the end of the center sills to the end of the bolster. This would change the brace from compression to tension, and could be counted on, even though badly distorted. It would also assist in taking the lateral drawbar pressure in curving. The heavy end sill will, in addition, strengthen the frame, and the angle will assist the gusset plate over the body bolster.

When the load of the car is of such a nature as to throw more weight on the side than on the center sills we get a partial equalization through the crossbearer to the truss-rods. But when the excess of the load is on the center sills we cannot count on much assistance from the side sills, for the crossbearer is hung to each of the side sills by two rivets. While the rivets are in good condition they may assist some, but their strength cannot be depended on, as the framing is so flexible that when it is laterally distorted there is imposed upon these rivets severe alternating strains, which will readily impair their strength and likely rupture them in time.

When we consider the steel underframe for a flat or gondola car, we have at times very different conditions to deal with from those of a box or stock car, one of which is a concentrated load. If we consider a concentrated load applied across the sills, the maximum allowable load, within safe limits would be 32,000 lbs., which is not up to the rated capacity of the car. If the load exceeds this limit, we will have a very large deflection and likely a permanent set in the sills, causing an injury to the framing. Again, when the load is of the above nature and immediately over the center sills, the only assistance obtained from the side sills is through the rivets fastening them to the crossbearer. Since these rivets cannot be relied on, we receive no assistance from the side sills, allowing the center sills to take the whole load. Even when the load is entirely distributed the side sills will deflect more than the center sills, as they receive the least support from the truss-rods.

In trying to maintain one design of underframing for the various types of cars there are two things we lose: first, the underframe for a box or stock car need not be as heavy as that of a flat or gondola car of the same rated capacity; second, we have the chance of lightening the weight of the gondola by making the sides assist the side sills in carrying their portion of the load. If we wish the last advantage referred to, it is necessary that the side sill should be immediately under the sides. While we might be able to use the same sills as in the framing for the box and stock cars, yet the spacing of the sills would be changed, thus changing the bolster and crossbearers. There is another feature which could be varied to advantage, by having individual framing for the various classes of cars. In the box and stock car construction the end sills are usually very close to or immediately under the end of the car body, while in the framing for gondola cars it is necessary to have the end sill outside of the end of the car body. This will increase the length of the sills, or else we lose in the volume of the car, which can hardly be afforded, as it impairs its carrying capacity. Thus we see the impracticability of endeavoring to use one underframe for all kinds of freight cars, but we may nevertheless use standard rolled sections for each design of underframing. In the particular design referred to there has been too much sacrifice of strength and rigidity throughout to gain lightness of weight in the car. While this underframing might do for a box or stock car with a few alterations, it is entirely too weak to stand the severe strains which would be imposed upon it if used for a gondola or flat car.

R. N. KENNINGTON.

Mr. George F. Wilson, who for twelve years has been superintendent of motive power of the Chicago, Rock Island & Pacific, has resigned and is succeeded by Mr. M. K. Barnum. Mr. Wilson begun service with this road as assistant general master mechanic in 1889. He was made general master mechanic in the same year and superintendent of motive power in 1891, and has a reputation second to none among motive power officials. Mr. Barnum entered the service of the Union Pacific as master mechanic in 1890, after having been connected with the Santa Fé and the Louisville & Nashville. He recently resigned to accept the position of assistant mechanical superintendent of the Southern Railway, which he now leaves to take up his new duties in Chicago.

NEW LOCOMOTIVE SHOPS.

READING, PA.

PHILADELPHIA & READING RAILWAY.

II.

LOCOMOTIVE SHOP.

The skill of the architects has relieved these large buildings of the flat and unattractive appearance of the ordinary construction of railroad shops. This is seen in the present engravings and in the photographs presented in the January number. This description concerns the main or locomotive-shop building. It is of modern steel-skeleton construction, with 17-in. brick walls and 8½ x 38-in. pilasters between the windows. The walls are on concrete footings and are tied to the steel columns, which are otherwise entirely independent of the walls. This building has three bays, with two rows of intermediate columns at 20-ft. centers, this being the distance between the centers of the shop pits.

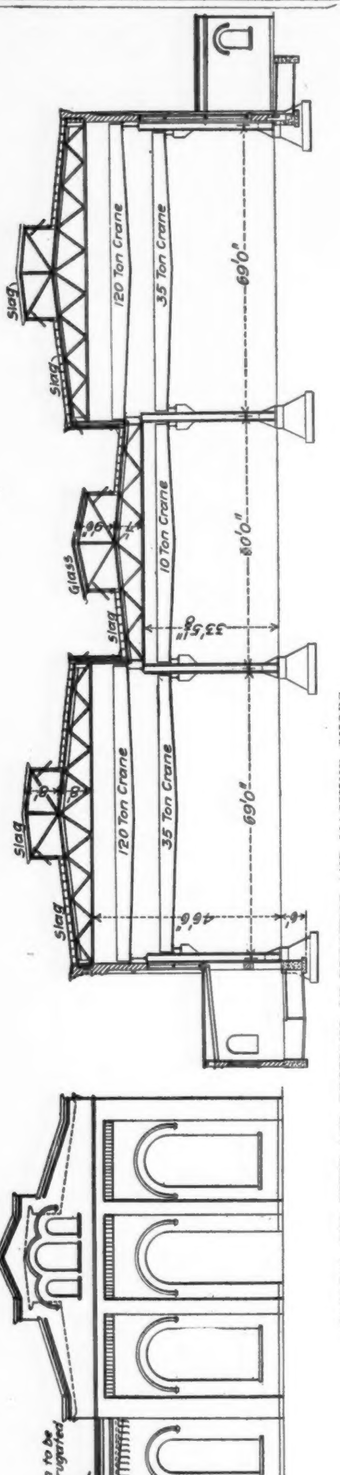
Steelwork.—The steelwork is substantial, and unusual accuracy was required in its construction and fitting. The wall and intermediate columns are very nearly alike up to the crane girders. They are built up of two plate and angle channels, with a double lacing of 2½ x ½-in. bars. Each column is anchored to a concrete granite capped pier, the concrete being of 1 part Portland cement, 2 parts of sand and 5 of broken stone (to pass a 2-in. ring). The column footings and caps are milled to secure a good surface. Upon the tops of these columns rest 4-ft. plate girders for the heavy cranes. The crane rails rest on top of the girders, which are in 20-ft. spans, with ¼-in. expansion spaces, one end of each span being fixed and the other provided with a specially designed expansion connection which insures the stiffness required for so heavy a runway. The rails for the 120-ton cranes weigh 150 lbs. per yard. Those of the 35 and 10-ton cranes weigh 85 and 70 lbs. respectively, and these are supported on brackets from the intermediate and wall columns. Specially strong construction was required for the heavy rolling loads.

Roofs.—This building has three separate roofs. The intermediate columns carry the ends of the machine-shop roof trusses, and extensions from the ends of these trusses carry the inner ends of the trusses over the erecting bays. The wall columns have extensions in the brick walls to carry the outer ends of these trusses. Purlins and bracing connect the trusses and carry the ventilating monitors.

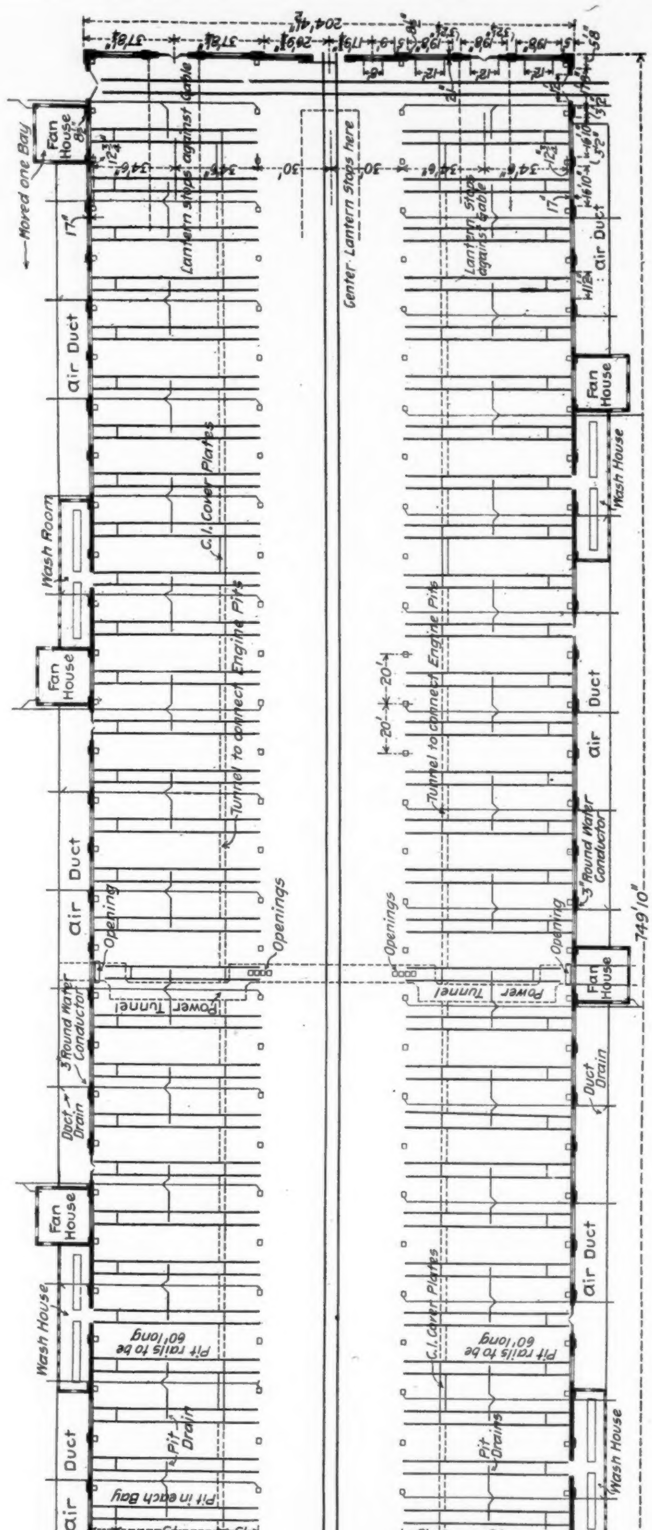
Roofing.—Hemlock boards, 1 by 8 ins., form the basis for the roofing. These are covered by 4-ply overlapping roofing felt laid in cement. As a minimum, 70 lbs. of felt were required per 100 sq. ft. of roof. Cement was spread over this, with a minimum of 10 gals. (including that between the layers of felt) per 100 sq. ft. of roof. Over this is an outer covering of crushed roofing slag.

Glazing.—The side windows are in three parts. At the top is a stationary semi-circular sash with a radius of 57 ins. Below that is a three-section window with rectangular sash, double-hung. The third, or lowest section, is stationary. At the end of the building is a similar window arrangement. In the sides of the roof monitors the sash are pivoted in the center, and so also are those in the walls over the intermediate crane girders, but here only alternate sash are pivoted.

Floor.—Except at the pits which are of concrete the entire floor of this building has a base of bituminous concrete composed of cinders and No. 4 coke-oven composition, in the proportion of 1 gal. to 1 cu. ft. of cinders. This was laid hot and well rammed. In this 6 by 6-in. yellow pine floor stringers are embedded at 4 and 5-ft. centers. These are covered with an under-floor of hemlock plank, surmounted by 1⅛ by 4-in.



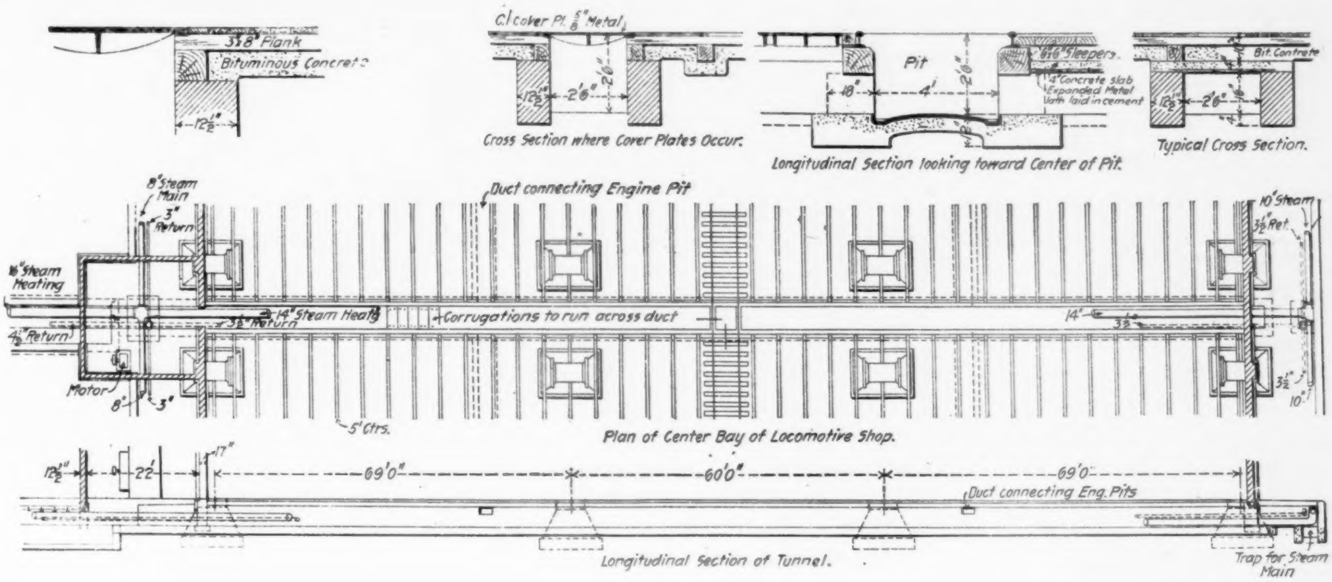
PARTIAL END VIEW AND SECTIONS OF ERECTING AND MACHINE SHOPS.



PLAN OF ERECTING AND MACHINE SHOPS.

NEW LOCOMOTIVE SHOPS AT READING, PA.—PHILADELPHIA & READING RAILWAY.

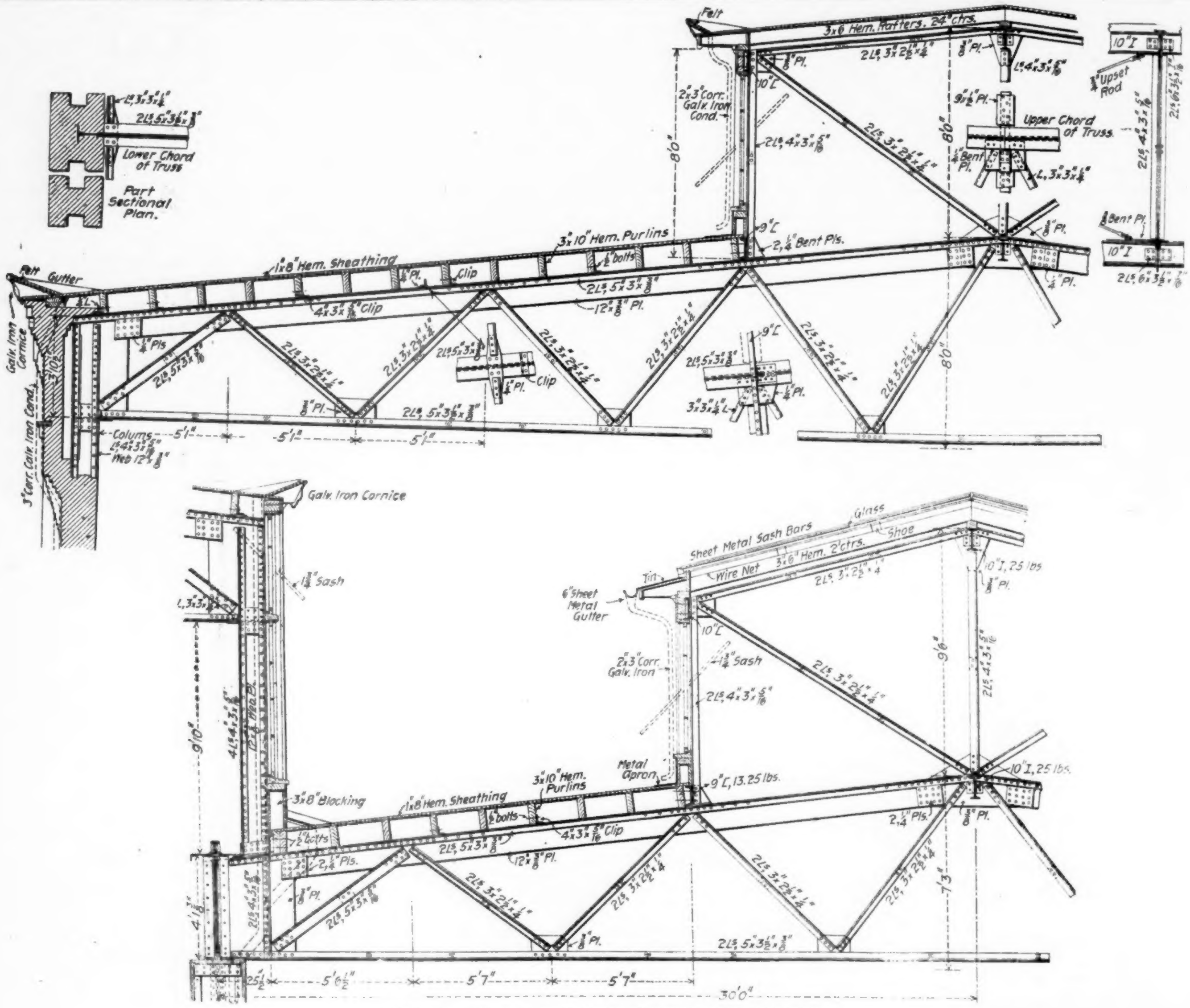
S. F. PRINCE, JR., *Superintendent Motive Power.* WILSON, HARRIS & RICHARDS, *Architects.*



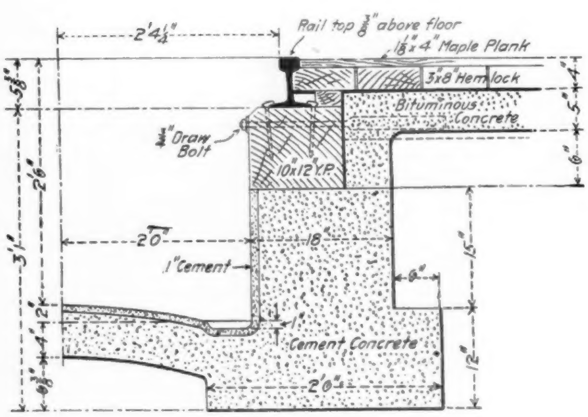
PLAN AND SECTIONS OF PIPE AND CABLE TUNNELS.

SHOWING CONSTRUCTION OF THE CLEANING PIT HOUSE.

NEW LOCOMOTIVE SHOPS AT READING.—PHILADELPHIA & READING RAILWAY.



ERECTING SHOP AND MACHINE SHOP ROOF TRUSSES.



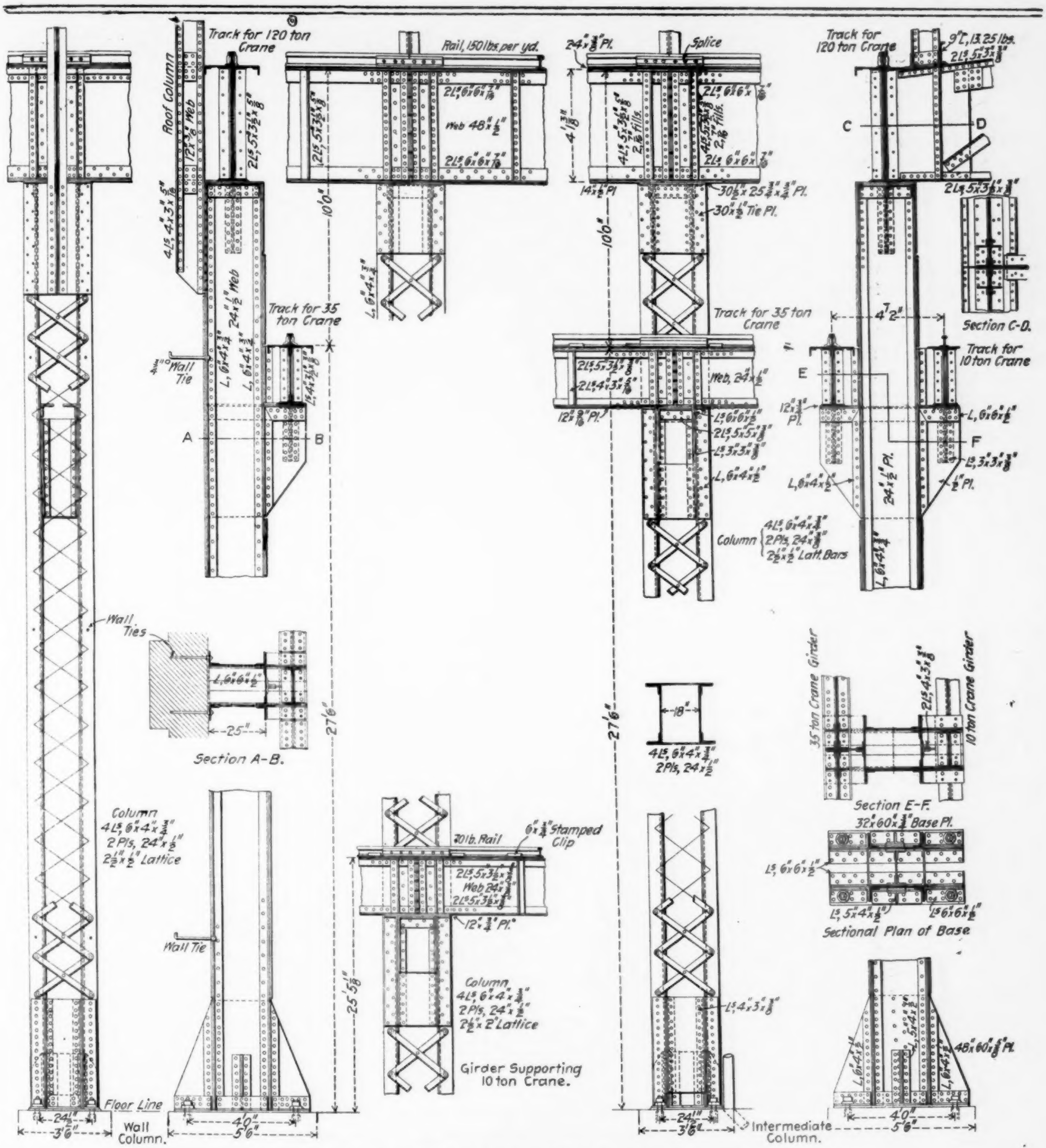
ENLARGED SECTION THROUGH PIT WALLS.

square edge maple flooring. The floor boards are not tongued on the edges, which renders it easy to make repairs.

The locomotive shop combines under one roof two 69-ft. erecting bays, with 35 pits each, and a central 60-ft. machine-shop bay, the building being 740 by 204 ft. The pits are 45 ft. long, with a space of 10 ft. to the outer wall and 15 ft. to the intermediate crane columns. The pits are 2 ft. 6 ins. deep and 4 ft. wide. They are of concrete, with crowned bottoms. The pits drain longitudinally, the entire plant being drained to 40 and 50-ft. wells to natural fissures in the underlying rock, leading eventually to the Schuylkill River. All pipes and electric cables enter the building from the power-house in a large tunnel, the location of which beneath the shop floor is indicated in the large plan. This will be illustrated in detail later. In the main tunnel the cables are placed in conduits of vitrified clay. This main tunnel extends across the shop, to carry the piping to fanhouses on the west side. Smaller tunnels open

NILES CRANES IN NEW LOCOMOTIVE SHOPS AT READING, PA.—PHILADELPHIA & READING RAILWAY.

							Motors—Horse-power.				Speeds in Feet Per Minute. Main Hoist.		Trolleys.		Bridge.		
Location in Shops.	Number of Cranes.	Capacity, in Tons.	Span, in Feet.	Lift of Hook, in Feet.	Number of Trolleys.	Number of Motors.	Main Hoist.	Trolleys.	Bridge.	Auxiliary.	Loaded.	Light.	Loaded.	Light.	Loaded.	Light.	Auxiliary, Loaded.
Erecting	2	120	69	30	2	6	44	10	44	21	8	20	50	80	150	200	50 (3-ton hoist)
Erecting	2	35	64	28	2	5	21	3	21	..	12	30	80	130	175	225	..
Boiler	1	35	64	28	2	5	21	3	21	..	12	30	80	130	175	225	..
Machine	1	10	55 ft. 10 in.	27 ft. 5 in.	1	3	21	3	21	..	15	35	100	150	200	250	..
Smith	1	10	56	28	1	3	21	3	21	..	15	35	100	150	200	250	..
Foundry	1	10	56	28	1	8	21	3	21	..	15	35	100	150	200	250	..



DETAILS OF COLUMNS AND TRACK SUPPORTS FOR CRANES.

NEW LOCOMOTIVE SHOPS AT READING.—PHILADELPHIA & READING RAILWAY.

into the main tunnel and extend the entire length of the shop on both sides at the inner ends of the locomotive pits. Cast-iron cover-plates are placed over the tunnels at intervals indicated in plan. Each pit is supplied with water and air piping, all of which is protected and out of the way, yet entirely accessible.

Excellent crane service is provided, the shop being sufficiently high for the double-deck arrangement on the erecting-shop sides. For convenience the general features of the various cranes in this shop are condensed into the table on page 56.

As explained in the previous article, the lower crane runways of the west side erecting-shop bay extend over a dwarf wall into the boiler shop. The boiler-shop 35-ton crane, or that of the erecting shop of the same capacity, may be run from one shop into the other—a most convenient arrangement, but one which is advantageous chiefly for the west bay.

An excellent idea of the appearance of the interior of this building was given by the large photograph on page 11 of our January number. A generous area of glass in the windows and roofs gives a uniform distribution of natural light. The floors are entirely unobstructed by anything that will interfere with the use of the valuable floor space or with the cranes. In the engravings just referred to will be found cast-iron racks with wide cross-arms to support cabs, while below these are other arms for the storage of pipes, rods and other fittings, to keep them off the floor. This view also shows the method of supporting the group motors upon cast-iron brackets. Other brackets, of steel plate, extend from the intermediate columns

toward the center of the machine shop to support the shafting.

At the northwest corner of the locomotive shop is the cleaning pit, in a small building reached by the end track of the large shop. This building is shown in engravings which are intended to be so complete as to be self-explanatory.

Seven fanhouses outside of the shop provide for the heating fans, which are driven by induction motors connected by chains. The underground air-ducts serve as intakes for the fans, taking air from openings under each window and conducting it to the fanhouses. The fans deliver the air directly into the shop through large rectangular openings through the walls, and without the usual distributing conduits, the heated air being delivered into the shop through seven large openings. This shop is provided with four washrooms of lean-to construction, located over the fan-ducts and adjacent to fanhouses.

The other buildings will be described in another article.

THE COMPARISON OF LOCOMOTIVES.

EXTENSION OF THE "BD" METHOD TO COMPOUND LOCOMOTIVES.

BY LAWFORD H FRY.

Considerable effort is being made at the present time to settle upon a method for comparing the proportions of locomotives, which shall be both simple and accurate, and which can be advantageously adopted as a standard. The chief requirement is a quantity which can be readily found from the general dimensions of a locomotive and which will serve as a measure of the relation existing between the capacities of the boiler and the cylinders. A quantity which thus measures the relation of steam production to steam consumption will be a measure of the steaming capacity of the locomotive, and in the AMERICAN ENGINEER for October, 1902, page 313, the present writer suggested, as a steaming capacity factor of this kind, the quantity given by the expression—

$$\frac{\text{Maximum cylinder tractive effort} \times \text{driving wheel diameter}}{\text{Heating surface}} \qquad (1)$$

This quantity was called "BD," B representing the ratio of cylinder tractive effort to heating surface, and D representing the driving-wheel diameter. The previous article analyzed the value of this capacity factor BD in the comparison of single-expansion locomotives, and it is now proposed to extend the analysis to cover compounds.

In estimating the value of any constant of comparison, such as "BD," two points are important, viz: that the constant shall be determined by the minimum of calculation and that the results obtained from its application shall have the maximum of accuracy. The capacity factor "BD" has claims for reasonable consideration on both of these points, and in addition it harmonizes well with the commonly used ratios of adhesive weight to cylinder tractive effort, and of heating surface to grate area. These two ratios bring under consideration the four fundamental factors of the locomotive:

1. Adhesive weight.
2. Cylinder tractive effort.
3. Heating surface.
4. Grate area.

As the ratios of the first of these dimensions to the second and of the third to the fourth are in common use in measuring the proportions of locomotives it seems only natural to inquire whether the ratio of the second to the third will not serve as the required measure of the relation existing between the heating surface and the cylinder power. Investigation of this question shows that the ratio of the cylinder tractive effort to the heating surface (ratio denoted by B) multiplied by the driving wheel diameter (D), that is to say the factor "B D," gives for every locomotive a constant of the proper form to stand as a measure of the important relation of heating surface to cylinder power. As stated above, this relation determines the steaming power of the locomotive and the quantity "B D" may therefore be called the steaming capacity constant or capacity factor of a locomotive.

The exact analysis of the quantity B D and the figures obtained from actual engines of all classes show that a locomotive having a low value of the capacity factor "B D" is suitable for high speed service, while a high value of the capacity factor points to the locomotive having been designed for low-speed service. Or interpreting the figures in another way: if two or more locomotives are running at the same speed and under similar cylinder conditions, a locomotive with a high value of the capacity factor "B D" will be working at a high rate of evaporation, that is, under less economical conditions and with a smaller margin of reserve power than a locomotive with a lower value of the capacity factor. At equal speeds and under similar cylinder conditions the rates of evaporation are proportional to the respective values of the capacity factor "B D." The speed referred to here is the rate of rotation of the driving wheels (revolutions per minute) and it is interesting to note that when the linear speeds (miles per hour) are the same the rates of evaporation are then proportional to the respective values of the ratio B.

Before going further it may be well to emphasize the fact that a high value of the capacity factor B D indicates a low steaming capacity, so that for free steaming a low value of the factor is desirable. It may be thought that it would have been better to have chosen a factor which was directly proportional to the steaming capacity instead of using the factor B D, which is inversely proportional to the capacity. This would, however, add to the amount of calculation required in determining the factor from the dimensions, or would involve the use of a factor which was a very small decimal. The factor B D was therefore suggested, and when once its meaning has been grasped it does not seem that there need be any particular difficulty in remembering that a low value of the factor B D indicates a large steaming capacity, and *vice versa*. The exact relations existing between the value of "B D," the rate of evaporation, the cylinder economy, and the speed will be shown by the following analysis.

Take the case of a locomotive, either compound or single expansion, running steadily, all the steam produced by the boiler being consumed by the cylinders. Then if the boiler has S square feet of heating surface and the rate of evaporation is b pounds of water per square foot of heating surface per hour, the total hourly evaporation is b S pounds of water. Let the engine be running at r revolutions per minute, corresponding to V miles per hour, and let the available cylinder tractive effort be p T, where T is the maximum available cylinder effort as calculated by the usual formula and p is a percentage factor, which is dependent on the speed and which reduces the available tractive power as the speed increases. Then the available horse-power developed is $\frac{pTV}{375}$, or putting $\frac{rD}{336}$ for V, the expression for the horse-power becomes $\frac{pTrD}{126,000}$, and if the locomotive consumes h pounds of water per available horse-power per hour, the total hourly consumption is $\frac{pTrDh}{126,000}$ pounds of water. Then equating this with the expression found for the total hourly evaporation

$$bS = \frac{pTrDh}{126,000}$$

and collecting to the left-hand side of the equation those terms consisting of dimensions of the locomotive

$$\frac{TD}{S} = \frac{126,000\ b}{prh}$$

but $\frac{T}{S}$ is denoted by B so that

$$BD = \frac{126,000\ b}{prh} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

By means of this expression the statements made above in regard to the properties of "B D" can be substantiated.

The value of p, that is the percentage of the maximum cylinder tractive effort which is available at the speed r, falls as r increases, but the rate of variation depends largely on the type of cylinders, and on the cut-off at which the engine is worked. In the case of compound cylinders the fall of p with increasing speed is much less rapid than with single expansion cylinders. The report of the American Railway Master Mechanics' Association for 1897 gives much information with regard to the relation between r and p at various cut-offs. Under ordinary running conditions the value of the product p r (and hence the horse-power of the locomotive) increases with the speed r. Now, from expression (2) it is obvious that for the same speed and cylinder conditions (p, r and h constant) the rate of evaporation b is directly proportional to the capacity factor "B D," so that of two engines under similar conditions that engine having the lowest capacity factor will be working with the lowest rate of evaporation, that is to say, under the most favorable boiler conditions. For locomotives which are to work at the same speed and with similar cylinder conditions a low value of the capacity factor represents to free steaming and a good margin of reserve boiler power. Further, in the case of locomotives with similar cylinders the water consumed per horse-power per hour (h) will be dependent on the cut-off rather than on the speed, so that with the same cut-off and the same rate of evaporation (h and b constant) the locomotive with the lowest value of B D will be capable of the highest speed. This follows from expression (2) and is very clearly confirmed when the figures for actual locomotives are examined. The results of compiling a number of such figures are shown in Table 1. In the AMERICAN ENGINEER for October, 1902, page 314, were given the results of an examination of the values of the capacity factor "B D" for 79 single-expansion locomotives, and to these are now added the figures for 45 Vauclain four-cylinder and 28 two-cylinder, in all 73, compound locomotives.

In analyzing these figures it was necessary to separate the locomotives according to the speed for which they were designed. This was a somewhat difficult problem, and the method adopted can only be considered approximate. The engines have been grouped according to the arrangement of their wheels. Prairie, Atlantic, and American (2-6-2, 4-4-2, and 4-4-0) type engines have been classed as high speed, while Consolidations, Mastodons, and Moguls (2-8-0, 4-8-0 and 2-6-0) are classed as low speed, the ten-wheelers (4-6-0) having the medium place.

Objections may be raised to this method of grouping, and it is certainly not perfect, as many of the 10-wheelers have been designed for high speed service, but after due consideration it seemed to have fewer disadvantages than any other method which suggested itself.

The actual values found for the capacity factors bear out the conclusions arrived at theoretically, and whether the maximum, the minimum or the mean values of "BD" are examined it is seen that for all types, whether single expansion or compound, the value of the capacity factor for high speed is lower than for medium, and the value for medium is lower than for low speed, as was to be expected from the theoretical reasoning.

For purposes of ready comparison the mean values of the capacity factors are given in Table 2 in round numbers, for single expansion and for both 2 and 4-cylinder compounds. It will be noticed that the values of "BD" run lower for the compounds than for the single expansion engines. This is noteworthy because in view of the fact that the water consumed per horse-power per hour (h) is considerably less for a compound than for a single expansion engine, it might have been thought that "BD" would have been larger for the compounds. The lower value of the capacity factor is undoubtedly due to the fact that the drop in available cylinder tractive effort is less rapid for compound than for single expansion cylinders. This coupled with the fact that live steam is admitted to both cylinders on starting a compound locomotive permits the use of compound cylinders showing a lower maximum tractive effort as calculated from the formula, than would be required of single expansion cylinders for the same service. Referring to equation (2) and speaking algebraically, the higher value of p for compound cylinders more than offsets the lower value of h, and as a result gives a lower value of "BD." It follows that the lower values of the capacity factor "BD" for the compounds do not indicate directly that these will steam more freely than the single expansion engines. In all cases where the factor "BD" is to be taken as a measure of steaming capacity or rate of evaporation, similar cylinder conditions must prevail.

TABLE 1.

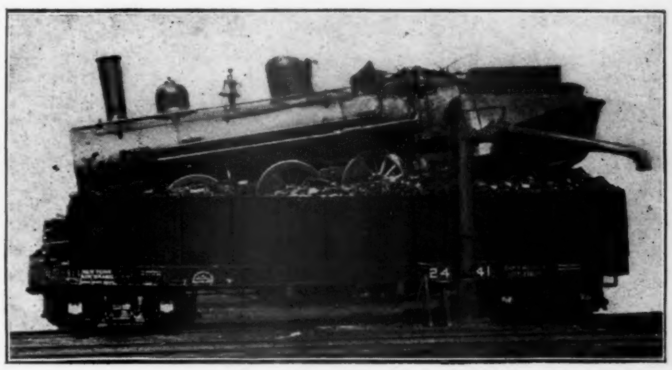
Type.	Service.	Number of Locomotives.	Values of B. D. Max.	Min.	Mean.
Single Expansion..	Fast	25	829	541	659
	Medium	25	900	646	753
	Slow	29	946	731	809
4-Cylinder Compound...	Fast	10	670	497	602
	Medium	10	807	526	650
	Slow	25	953	645	772
2-Cylinder Compound...	Fast	..	...	...	...
	Medium	12	798	579	678
	Slow	16	948	719	809
Both Types Compound...	Fast	10	670	497	602
	Medium	22	807	526	665
	Slow	41	953	645	785

TABLE 2.
Mean Values of BD.

	Fast.	Medium.	Slow.
Single Expansion	650	750	800
4-Cylinder Compound	600	650	775
2-Cylinder Compound	...	675	800

THE WOODEN CAR HAS NOT REACHED ITS LIMIT.

This switch engine was backing a string of box cars on the main line and was caught on the pilot of a fast mail engine



VIEW OF WRECK, SHOWING ENGINE RESTING UPON CAR.

hauling its train at 60 miles per hour, moving in the same direction. The switcher was handsomely lifted into the load of a coal car and only the pilot of the mail engine suffered. No one was hurt, and, if wrecks must occur, this is a good kind. The capacity of the car is 80,000 lbs. It carried 70,000 lbs. of coal and its overload of 137,000 lbs., to the shops, very comfortably, its proved capacity being 207,000 lbs.

Speeds for flue rattlers is a subject which has evidently not received much attention. It is said that at the Collinwood shops of the Lake Shore an increase of speed from 20 to 25 turns per minute doubled the capacity of the machine in cleaning flues.

Mr. W. W. Grant, who for eight years has been connected with the Westinghouse Electric & Mfg. Co., has been elected vice-president and sales manager of the Fibre Conduit Company with head offices at Orangeburg, New York.

(Established 1832.)

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EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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CONTENTS.

Notwithstanding the fact that we printed more copies of the January number than of any previous issue of this journal, the edition was almost entirely exhausted at the middle of January. We are sorry that many of the new subscriptions for the year 1903 must necessarily begin with the February issue.

This journal has the honor of printing in this issue the first article of a comprehensive series from the pen of Mr. R. H. Soule upon the subject of the modern railroad shop, the presentation of which will require at least a year. Mr. Soule has no superior as an authority on this subject. He is fitted to discuss it by technical training as a mechanical engineer, by an experience of seventeen years in motive-power service, and also by close contact with recent developments in having been retained as consulting engineer in planning a number of large new shops on some of the most important trunk lines. Our readers will remember that he also designed the shops of the Buffalo, Rochester & Pittsburgh Railway, illustrated in our April and May issues of last year. This journal and its readers are fortunate in having the opportunity to study shop problems which this treatise by Mr. Soule promises to afford. We desire to stand for the practical application to railroads of the principles which underlie commercial success, and it is confidently believed that this work will not only be valuable as a study of shop problems, as a record, and a guide to future practice, but that it will exert a powerful influence in the intelligent treatment of what has become one of the greatest engineering and business questions with which railroad officers of the present time have to deal. The articles cannot fail to bring in a new era in railroad-shop construction, the influence of which is expected to extend far beyond the limits of the subject treated. Such a work as this has never before been attempted, and it can only be properly undertaken by one having the qualifications and attainments of Mr. Soule.

The increase of output of machinery driven by electric motors is the great desideratum which is achieved by the application of direct-connected motor drive, and far outweighs in importance the several other advantages incidental to this method of driving—the saving of head room, for example, the absence of long lines of shafting, and the avoidance of power wastes. Indeed, the value of the power, whether furnished by shafting or by the electric motor, as compared with the importance of the increased product, is nearly negligible.

It is encouraging to note the efforts now being made to devise a satisfactory system of comparing locomotives of various designs in order to make a study of the factors which go to make up capacity for sustained power. In this issue will be found a suggestion from Mr. E. L. Coster, which is believed to be new and seems to be excellent. Briefly stated, Mr. Coster suggests expressing the heating surface in per cent. of the total maximum tractive power. This is an important subject and correspondence from our readers is invited.

The actual limitations and shortcomings of the older styles of machine tools seriously hamper them in meeting the demands of these modern times—probably no one particular is found, in establishing piece-work rates, to involve a greater waste of time than that of changing driving speeds and feeds on, and otherwise adjusting, machine tools, especially of the older models, and this is the great factor that prevents so many machine shops equipped with old styles of tools from successfully competing with piece-work shops equipped with modern tools. This criticism applies, of course, only to machine tools of the older styles; the machine tool manufacturers of to-day in this country are to be given credit for their commendable progress, and may be said to be well abreast of

the times. But it is in this respect that our present old-established railway repair shops are open for great improvements with the respect to the cost of doing work; careful attention to points of feeds and speeds of driving above mentioned will, when purchasing new machines, provide for great reductions in the times required for certain machining operations from what would be required on the old style plain machines.

It is evident that railroad officers appreciate the necessity for improved facilities for handling and storing coal for locomotive use, the cost of this service with poor facilities having attracted attention. Of late a large number of improved chutes have been built and in nearly every case the item of labor expense in handling the coal has been very carefully considered. A low cost of handling is, however, not the only important consideration in this equipment; in fact, it is not the most important one. There is serious danger of throwing to the winds the coal records of the enginemen, and this has not been considered at all in coal chute construction on several leading roads during the past year or two. If a coal chute does not provide means of knowing how much coal is delivered to each engine it cannot be considered satisfactory or complete. Coal records never have been and cannot be satisfactory in their effects upon the economy of consumption unless the coal is actually weighed at the chutes. This is the opinion of motive power officers, and it should be considered by officers of other departments who have to do with the construction of this equipment. It is difficult to state the value of weighing facilities, but it is safe to measure it by that of coal records themselves; because records based upon anything except actual weight are ineffective.

The entire fuel question might profitably be placed in the hands of a competent man, having the necessary knowledge and experience and authority to advise and direct in all matters pertaining to coal, from its purchase to its consumption. In fact, the important character of the fuel question on large roads already demands such treatment.

Almost everyone who has had to do with the setting of piece-work prices has been disconcerted by comparing the time a workman has taken to do a certain piece of work with the theoretical time that had been figured out for it. The usual plan has always been, when setting a piece-work price, to carefully calculate the amount of surface to be machined, and then by allowing certain cutting speeds and rates of feed, the theoretical time it should take to remove the material is arrived at. To such time is added what is considered necessary for setting the work, changing the tools, etc; but in most instances the line of variation between theory and practice is, to say the least, confusing. On investigation it is invariably found that it has been omitted to allow for time lost in playing round and fiddling with the machine itself—taking ten minutes to alter this feed, five minutes to alter that motion, and so on. If a machine is to be bought for any work that requires certain definite machining, why not calculate theoretically the time required to do the work, and put this time down as the maximum efficiency. If then you are going to purchase a tool for doing that work, why not set this time down in your specification and get makers to state what percentage of efficiency they will guarantee on your time? The day has gone past when a good tool means merely a machine well and solidly built, and capable of doing first-class work. The element of "time efficiency" is now the important clause in the contract. What use is it to a manufacturer if he has a number of splendid tools made by first-class makers and capable of doing good work at the end of the next century if his neighbor is equipped with a plant which enables him to undersell by 25 per cent.?

RAILWAY SHOPS.

By R. H. Soule.

I.

INTRODUCTORY.

The arrangement and proportions of railway shops constitute a problem which is demanding careful consideration at the present time, and which is certain to increase in future importance. This condition is largely due to the change from a period of depression to a period of unparalleled prosperity during the last ten years. At the beginning of that period railway managers were enforcing the most drastic measures of economy, and officers in charge of shops effected surprising reductions in operating expenses which came under their supervision or control. Every line of disbursement of either labor or material was relentlessly followed up, and savings insisted upon. What was accomplished by this crusade is a matter of history; it was the greatest lesson in economy that shop officers had ever enjoyed. Then gradually came the increase of business which has culminated in present conditions, which make such unprecedented demands on railway shops that maximum output has been forced to the front as an absolute requirement. This chain of circumstances has therefore emphasized economy and output as the elements of prime importance in the operation of railway shops. Up to the time of this awakening there prevailed on most lines a comfortable complacency and satisfaction in things as they were; this feeling has now given way to a determination that existing shop plants shall be modernized, and that all new plants shall be so proportioned, arranged, equipped and organized as to meet present-day requirements as regards economy and output. This necessity for more careful work in shop design has also been stimulated by the fact that the continued merging of railways into great systems has justified larger outlays of capital for the purpose of establishing central repair and construction plants.

In approaching the problem of designing a central shop plant the fact stands out that the problem is a very complex one, and as it is pursued to completion the details multiply. It involves the proper provision of space, power, tools and appliances for all the varieties of labor which are concerned in the construction or repairs of locomotives and cars, passenger and freight. To establish such facilities in proper proportion to one another requires that many assumptions must be made, involving the relative amount of work of the several classes which is to be done. Such assumptions are apt to be faulty, owing to the fact that traffic conditions change frequently and quickly on most railways. It is for that reason that many railway shop plants have had to be modified in certain particulars after having been occupied and used a year or two. But, nevertheless, such preliminary assumptions must always be made, and the fact that they are apt to be misleading affords the strongest argument for adopting them only after the most careful consideration. The variety of classes of labor to be provided for is very great, but there is no department of a railway which has to handle so many varieties of material as the motive power department. A count of items on the semi-annual inventories of an Eastern line, some two years ago, showed that the maintenance of way department used about five hundred varieties of shapes, sizes and materials, while the motive power department used about five thousand. A modern shop must provide for the proper housing, classification, handling and distribution of these materials.

New and modifying influences have also crept into the shop problem from the outside. The practical and successful application of electricity as an agent for distributing and applying energy, whether for power or for lighting purposes, has dis-

credited old and well-understood systems. The relative merits and the line of demarkation between the legitimate use of direct current and alternating current apparatus being a matter on which even the electrical experts fail to agree, the shop designer must proceed with the utmost caution. Several different methods of motor speed control are advocated, and apparatus with this object in view appears to be multiplying. The conflicting claims of circuits for power and for lighting, as between direct and alternating currents, must be met, considered and perhaps compromised.

New tool steels of increased cutting power have upset the traditions of feeds and speeds for machine tools, and the intelligent use of such steels has increased the output per tool. Both humane and business considerations call for the most improved methods of heating, ventilating and lighting buildings. With electrical distribution there is no need or justification for small isolated units of power, and the central power plant assumes first importance as the one source of energy, whether used for power, lighting or heating; power being distributed as electricity, compressed air, or fluid under pressure (hydraulic power); lighting being accomplished by either arc or incandescent lamps, and heating being effected by either exhaust or live steam. Various types of boilers being available a selection must be made with due regard to both first cost and economy of maintenance. The engine equipment must be chosen not only as regards type and economy, but must be subdivided into such units as can be combined to the best advantage in order to secure the greatest possible efficiency under a varying total load. The cost of coal and water supply will determine the choice as between condensing and non-condensing engines, as well as between simple and compound. The gas engine is a close competitor with the steam engine on the score of thermal efficiency, and the day may not be far distant when a gas producer plant may be needed instead of the boiler plant, as a basis of power supply. Coal being the accepted fuel, whether for use in generating steam or producing gas, provision should be made for storing and handling the supply, and handling and removing ashes, with the least expenditure of labor. The problem of draft requires close analysis of conditions before choosing between the tall chimney and the short, the latter to be supplemented by mechanical appliances for inducing draft. To determine the gross amount of power to be provided at the central station it is necessary to prepare charts showing what is likely to be the load for each department of the shops or each class of service for each hour of the day, and from such separate or individual charts prepare a total load chart, from which the desired maximum can be deduced. It is not probable that the storage battery will be much used as an adjunct to railway shop power plants as the total load does not ordinarily fluctuate between such wide limits as in central stations where electric energy is supplied for traction or for lighting purposes.

These facts indicate that the power plant is a complex problem, but nevertheless it is a problem of such a nature as to be susceptible of treatment by well understood engineering methods. On the other hand, the problem of the proper proportions of the buildings to be occupied by the different departments of a railway shop, and their proper grouping and spacing cannot be solved by appealing to any existing formulæ, but only by an intelligent analysis of recent examples of what are believed to be the best practice under conditions approximating those which exist to-day. This analysis should not fail, however, to recognize defects, if such exist, in shops which in general are thoroughly modern.

It will no doubt be possible by this process to deduce certain constants, factors, and ratios which may be available for future use, and this inquiry is made with that object in view. Where alternative arrangements or methods are found in practice their relative merits will be discussed.

(To be continued.)

A PREMIUM PLAN FOR TRAVELING ENGINEERS.

The Chicago Great Western has a plan, with reference to locomotive coal records, which is worthy of general adoption. Coal records are carefully kept, the chute reports being sent daily to the superintendent. Coal allowances are made for each class of engine and each kind of service as follows:

Trains Nos. 1 and 2 between Minneapolis and Chicago, 1.0 ton per 10,000-ton miles.

All other passenger and branch trains, 1.2 tons per 10,000-ton miles.

All stock or time freights, .8 ton per 10,000-ton miles.

All other freights, .9 ton per 10,000-ton miles.

Switching, work train, or helper engine, .25 ton per hour.

Idle under steam, .025 ton per hour.

The traveling engineers are paid a certain guaranteed minimum salary and their actual rates per month are based upon the per cent. of excess made by the engines on the divisions with which they are connected. The traveling firemen receive a rate which is proportionate to that of the traveling engineer of the same division. Of course these allowances must be very carefully determined and the grades, speeds and character of the locomotives must be considered. They would vary greatly on different roads. For the Chicago Great Western Mr. Van Alstine has prepared a schedule for each division giving the rates of pay per month for various percentages of excess. The ~~plan has been in effect since May 1, 1902, and is reported to be~~ schedule given here has been in effect since May 1, 1902, and is reported to be very satisfactory. The original plan of making allowances per 10,000-ton miles for each train, or class of trains, has been in effect on this road for over ten years. Traveling engineers were put on about two years ago and soon after were placed on the premium basis.

The application of electric traction to heavy traffic on present steam roads is settling itself in a natural and interesting way, and it is to be introduced because of conditions which cannot be met by steam locomotives. In the improvements of the New York Central terminal and the entrance of the Pennsylvania into New York City will be seen the first entrance of electricity on a large scale into the field of heavy transportation service. The real beginning was made in the Baltimore & Ohio tunnel, but the present schemes will open a new epoch in electric transportation. On the New York Central all suburban trains from Croton, on the main line, and White Plains, on the Harlem division; on the New York, New Haven & Hartford all suburban trains from a point yet to be determined, and on all three lines all passenger trains, from whatever distance, will be drawn into the Grand Central station by electric motors. This, together with the contemplated changes in the station itself, will cost about $25,000,000 and the electric installation will be the largest ever considered. Little can be said as yet concerning the extent of the electric work on the Pennsylvania terminal, but it will be great, and the extension of electric traction on Long Island and toward Philadelphia will follow as a matter of necessity. It seems perfectly reasonable to expect the Pennsylvania to ultimately use electric motors for all its passenger traffic between New York and Philadelphia as a natural growth of the application in the tunnel and at the new terminal. Without an attempt to forecast the future, its present plans are sufficiently great to center the attention of engineers and railroad officers for several years, and there can be no question of the fact that there is more heavy electric work to come. These problems involve new questions for which there are no precedents. It is a matter of the greatest interest to railroads to be prepared to meet these new problems, and a noteworthy incident to the situation is the opportunity which it offers to young men who combine abilities in railroad and electrical work.

PASSENGER LOCOMOTIVE—NORTHERN PACIFIC RAILWAY.

4—6—2 TYPE.

BUILT BY THE AMERICAN LOCOMOTIVE COMPANY.

This type of wheel arrangement seems to be likely to become popular. There seems to be a rather persistent impression that a two-wheel leading truck is less satisfactory than one having four wheels, but, as far as we know, it has not been demonstrated that the two-wheel truck is in any respect deficient. This is a very large and powerful passenger engine which has not been exceeded in heating surface except by a very few examples in previous practice, as the table in our issue of last June indicates. The Missouri Pacific locomotives of the same type, illustrated in September of last year, were somewhat larger in this respect, while being also lighter in total weight. The figures of the two designs furnish an interesting comparison. The Northern Pacific has been very favorable to compounds, experience on that road having been satisfactory. It is not understood that this departure indicates a decided adverse step with reference to them. This engine has piston valves with inside admission, frames having a single bar at the cylinders and slabs at the firebox, and the trailing truck is of the Player type used on a number of locomotives built at the Brooks Works of this company, but in this case its construction has been somewhat changed, as will be indicated in a later article. It was the intention to present at this time a number of the details of this locomotive, but because of the space required for other purposes these will be presented later. The following ratios and table of dimensions present the leading features of the design, of which about 50 engines have been built. Specially interesting features of the construction will be presented in another article:

RATIOS.

Tractive power = ...31,000 lbs.

(1) $\frac{\text{Heating surface}}{\text{Cylinder volume}}$ = ... 302

(2) $\frac{\text{Tractive weight}}{\text{Heating surface}}$ = ...38.7

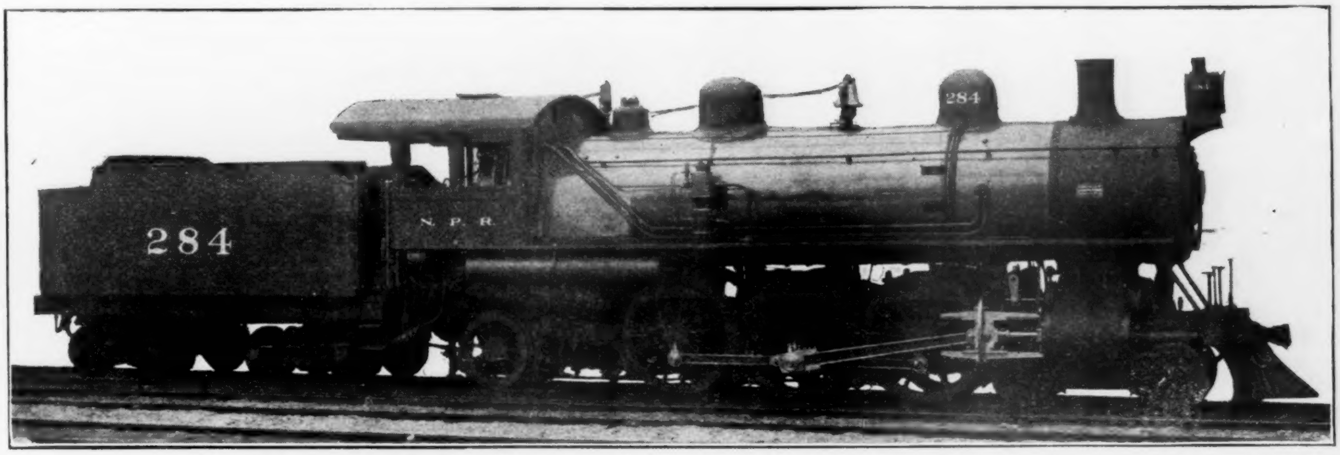
(3) $\frac{\text{Tractive weight}}{\text{Tractive effort}}$ = ...4.32

(4) $\frac{\text{Tractive effort}}{\text{Heating surface}}$ = ... 8.9

(5) $\frac{\text{Heating surface}}{\text{Grate area}}$ = ...73.7

(6) $\frac{\text{Tractive effort} \times \text{diameter of drivers}}{\text{Heating surface}}$ = ... 614

(7) Heating surface in per cent. of tractive power = ...11%



PASSENGER LOCOMOTIVE, 4—6—2 TYPE, NORTHERN PACIFIC RAILWAY.

A. E. MITCHELL, *Superintendent Motive Power.* AMERICAN LOCOMOTIVE COMPANY, *Builders.*

NORTHERN PACIFIC PASSENGER LOCOMOTIVE.

4—6—2 TYPE.

General Dimensions.

Fuel	Bituminous coal
Weight in working order	202,000 lbs.
Weight on drivers	134,000 lbs.
Weight engine and tender in working order	325,400 lbs.
Wheel base, driving	12 ft.
Wheel base, rigid	12 ft.
Wheel base, total	33 ft.
Wheel base, total, engine and tender	58 ft. 4½ ins.

Cylinders.

Diameter of cylinders	22 ins.
Stroke of piston	26 ins.
Horizontal thickness of piston	5½ ins.
Diameter of piston rod	4 ins.

Valves.

Kind of slide valves	Piston type
Greatest travel of slide valves	6 ins.
Outside lap of slide valves	1 in.
Inside clearance of slide valves	⅛ in.
Lead of valves in full gear: Line and line in full gear, forward, ¼-in. lead at 6½ ins. cut-off	

Wheels, Etc.

Number of driving wheels	6
Diameter of driving wheels outside of tire	69 ins.
Material of driving wheels	Centers, cast steel; centers, 62 ins.
Thickness of tire	3½ ins.
Driving box, material	Cast steel
Diameter and length of driving journals	9½ ins. and 9 ins. diameter x 12 ins.
Diameter and length of main crankpin journals	Main side 7¼ ins. x 4¾ ins., 7 ins. diameter x 6½ ins.
Diameter and length of side-rod crankpin journals	5ins. diameter x 4½ ins.
Engine truck, kind	Four-wheel, swing bolster
Engine truck, journals	6 ins. diameter x 11 ins.
Diameter of engine truck wheels	33 ins.
Kind of engine truck wheels	Steel tired spoke center

Boiler.

Style	Straight
Outside diameter of first ring	70 9-16 ins.
Working pressure	200 lbs.
Thickness of plates in barrel and outside of firebox	25-32 in., 13-16 in. and 9-16 in.
Firebox, length	90 3-16 ins.
Firebox, width	75⅝ ins.
Firebox, depth	Front, 78½ ins.; back, 66 ins.
Firebox plates, thickness	Sides, 5-16 in.; back, 5-16 in.; crown, ⅜ in.; tube sheet, ½ in.
Firebox, water space	Front, 4½ ins.; sides, 3½ ins.; back, 3½ ins.
Tubes, number	301
Tubes, diameter	2¼ ins.
Tubes, length over tube sheets	18 ft. 6 ins.
Firebrick, supported on	Four water tubes
Heating surface, tubes	3 264.3 sq. ft.
Heating surface, water tubes	23.02 sq. ft.
Heating surface, firebox	175.1 sq. ft.
Heating surface, total	3,462.42 sq. ft.
Grate surface	47.2 sq. ft.
Exhaust pipes	Single
Exhaust nozzles	5¼ ins., 5½ ins. and 5¾ ins. diameter
Smokestack, inside diameter	18 ins.
Smokestack, top above rail	14 ft. 10¾ ins.

Tender.

Style	Eight-wheel
Weight, empty	49,400 lbs.
Wheels, number	8
Wheels, diameter	33 ins.
Journals, diameter and length	5½ ins. diameter x 10 ins.
Wheel base	17 ft. 2 ins.
Tender frame	Steel channels
Water capacity	6.000 U. S. gals.
Coal capacity	12 tons

ELECTRICITY IN RAILROAD SHOPS.

Mr. L. R. Pomeroy, of the General Electric Company, has sounded the keynote to the railroad repair shop situation in his recent paper upon the above subject, delivered before the Central Railroad Club. The importance of the part that electricity is playing in modern railroad shop practice was never before made so prominent. The convenience of an electrical power distribution system, with which the shop electric lighting may be furnished from the same dynamos, cannot be overestimated.

Mr. Pomeroy states that the two great advantages of the direct current, so far as power transmission is concerned, are slow speed, and variable speed on the motor itself. With a slow-speed motor it is possible often to make a sufficient reduction of speed to the normal required by the machine by means of gearing with a motor using a slight variation in field winding, increasing the cost of the motor only about 5 per cent. over standard types; an increase in speed of 25 per cent. above normal may be obtained by field weakening, or 40 per cent. below normal by interposing armature resistance is possible.

While it is not advisable to presume on using the full range of such speed variation continuously, yet in conjunction with the step cones, or back gears, any intermediate speed between the cones or gears can be exactly met. Such speed variation is feasible and practical. This represents the cheapest form of utilizing motor speed variation, from the viewpoint of first cost.

Next in point of cost is the use of a special type of motor, giving 100 per cent. field regulation. By this type of motor the varying requirements of most any tool can be met at a slightly increased cost over constant-speed or standard motors.

By varying the current flowing in the field coils of a motor the strength of the magnetic field is changed and the speed of the motor varied. With any setting of the field the motor will give constant speed under changes of load, and this method, therefore, avoids the greatest objection to rheostatic control.

A motor of ordinary design will not permit of any considerable field weakening, without deleterious sparking at the commutator, but with a special motor having small armature reaction a variation in speed of two to one can readily be obtained, and when delivering a constant horse-hower the current will be approximately the same at all speeds because the potential across the armature terminals is always the same.

Mr. Pomeroy states that mere economy of transmission is one of the least advantages to be gained by electric driving; the cost of power in fuel is so small a part of the total cost of operation that it can be practically ignored, on account of the other advantages and larger savings resulting from the introduction of electric transmission. He estimates the factors which enter into the cost of production at the following average values:

Fuel	3 per cent. of the total cost of the article
Labor	47 per cent. of the total cost of the article
Material	50 per cent. of the total cost of the article

The conclusions of the paper are that electric shop driving permits of a centralized power generation for light and manufacturing purposes; maximum efficiency of workman, machines and labor involved; intensified production at best speeds and at the power limit of machines, with improved quality, maximum output and reduced cost.

The cost of maintenance is a minimum. The depreciation is less than in any other system. The saving effected is much more than sufficient to pay for all the incidental repairs and renewals to the electric machinery or the wiring system. Attendance and supervision can be largely centralized and reduced to a minimum.

MACHINE TOOL PROGRESS.

FEEDS AND DRIVES.

BY C. W. OBERT.

II.

In the preceding article of this series were described two admirable variable-speed positive-drive mechanisms which are applied to the feeds of lathes. In this issue a mechanism of similar character, which has been applied to the Cincinnati milling machine, will be considered. This device belongs to the same general classification of positive-drive mechanisms with the speed range varying through a definite number of steps by the use of gears.

The variable-speed device, applied by the Cincinnati Milling Machine Co., Cincinnati, Ohio, to the feeds of their plain and universal milling machines consists of two separate and distinct mechanisms, one of which transmits the power to the

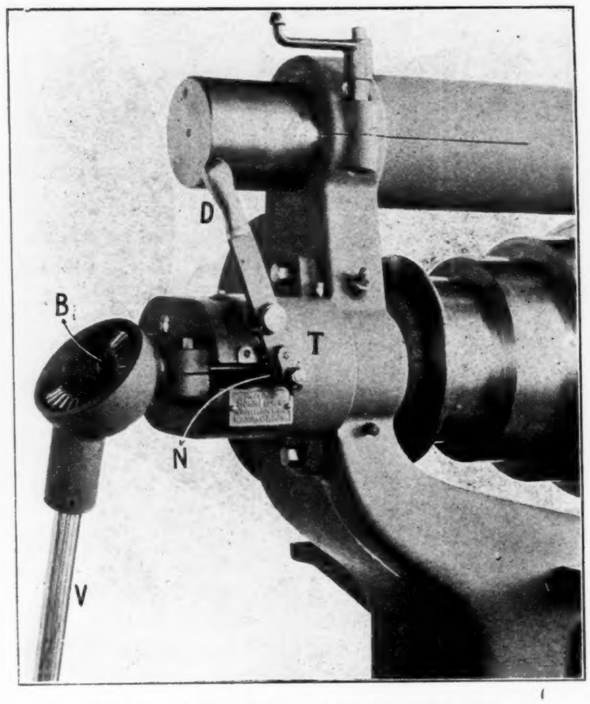


FIG. 7.—FRONT VIEW OF UPPER GEAR BOX.

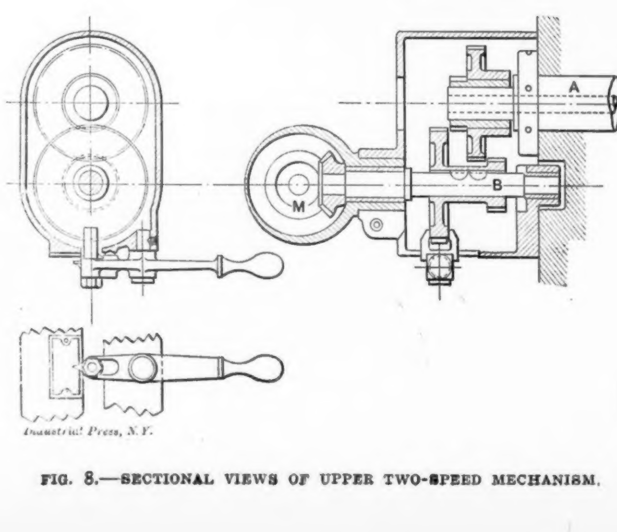


FIG. 8.—SECTIONAL VIEWS OF UPPER TWO-SPEED MECHANISM.

other at one of two different speeds, while the other delivers the power thus received to the machine's feeds with a variation possible of eight different speeds. The latter eight-speed mechanism consists of the nest of gears and selective gear principle described in our preceding issue, although the same result is secured in a different manner. Figs. 7 and 9 are external views respectively of the two above mentioned gear mechanisms enclosed in their cases, while Fig. 8 is a sectional plan view of the two-speed gear mechanism, and Figs. 10 and 11 are an external rear view with covers removed and sectional views, respectively, of the eight-speed gear mechanism.

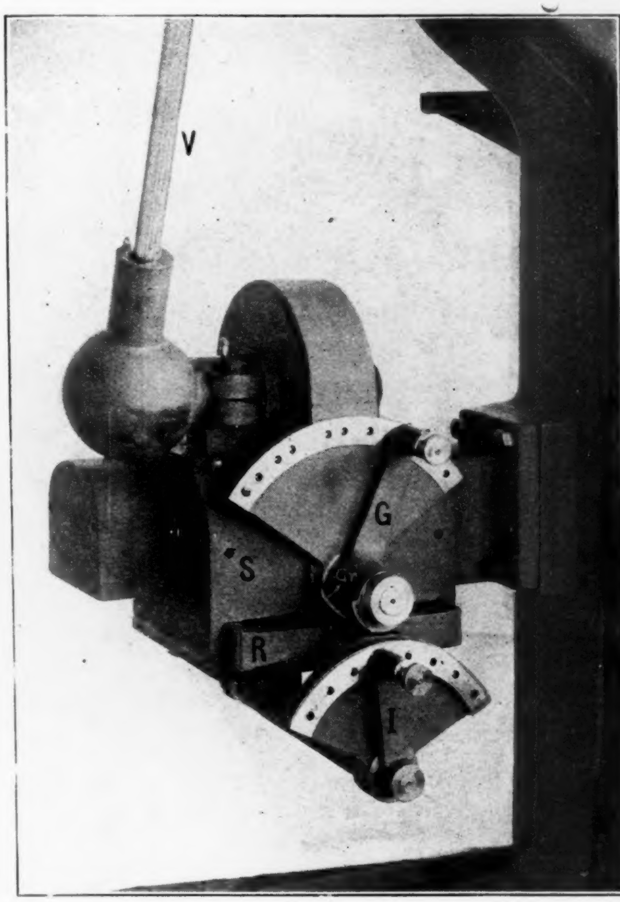


FIG 9.—FRONT VIEW OF LOWER GEAR BOX.

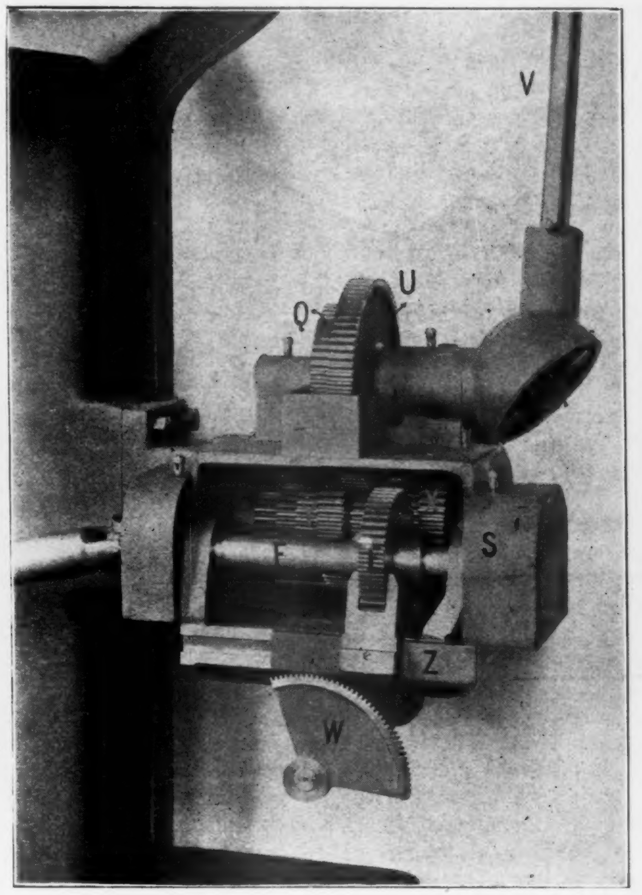


FIG. 10—REAR VIEW OF LOWER GEAR BOX.

The two-speed gear mechanism, T, Fig. 8, is located so as to receive its motion from an extension of the milling machine spindle, A, and transmits power through a pair of miter gears and a vertically inclined shaft, V, down to the eight-speed gear mechanism below. The variation of speed is obtained in mechanism, T, by means of a method of change-gears. On the spindle extension shaft, A, there are two gears, a large one and a small one; on the shaft, B, there are two corresponding gears, one of which will mesh with each of those on A, both being mounted upon a sleeve which is splined on and may slide along the shaft, B.

The position of this sleeve and gears is governed by the guide block, N, embracing the larger gear on the shaft, B, so that by moving this guide block through the medium of handle, D, either pair of gears may be brought into mesh. A middle position of the handle and gears, which is the position shown in Fig. 8, clears both pairs of gears out of mesh and thus throws all of the feeds out of gear. This makes two speeds possible with this combination, one giving an increase of speed and the other a decrease of speed, and in the middle position no motion is transmitted.

The eight-speed mechanism, S, is, as was before stated, situated below the two-speed mechanism, receiving its motion from the same through the vertically inclined shaft, V. The motion is received from shaft, V, through another pair of miter gears onto a shaft, C, carrying the two feed gears, Q and U, Fig. 10. Then upon a shaft, O, there are arranged two nests or cones, X and Y, of four gears each, the four gears of each nest being keyed to a sleeve fitting loosely on the shaft, so that either nest may revolve as a solid unit on the shaft independently of the other. These two gear cones are given independent motions by the feed gears, of which the larger

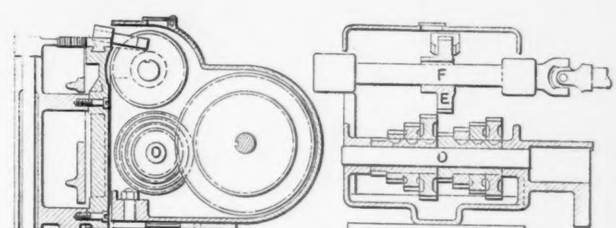


FIG. 11.—SECTIONAL VIEWS OF LOWER EIGHT-SPEED MECHANISM.

gear, U, meshes permanently with the smallest gear of nest, X, giving that nest a relatively high speed, and the smaller gear, U, meshes permanently with the smallest gear of nest Y, giving that nest a relatively slow speed. In this way a wide range of speeds is available, in eight steps, by virtue of the two nests revolving at widely different speeds.

The manner of delivering motion from any one of the gears upon the two nests is very similar to that of the gear box first described in this series, differing mainly in the provision for bringing the receiving pinion, E, up against the cones. This intermediate gear, E, is feathered on the shaft, F, so as to slide along it, and is brought into mesh with any one of the eight cone gears by shifting the two levers, G and I, shown in Figs. 9, 11 and 12. The lower lever, I, moves the gear, E, along its shaft, F, through the medium of a toothed sector, W, which meshes with the rack, Z, upon which is carried the guide block embracing the gear, E.

The proper position of the lever I, for a position of mesh by gear, E, is indicated by the eight holes upon the quadrant at the front into which the lever locks. After the gear, E, has been brought into position for mesh by means of lever, I, it is moved forward into mesh by the lever, G, which does so by moving the entire lower slide, R, of the box up toward the cones, the proper adjustment of this lever for bringing the pitch lines of the gears into coincidence being indicated by holes in its quadrant into which it locks. This movement of the slide, R, with respect to the lever, G, which is mounted on the frame of the mechanism, is accomplished by means of a helical groove, Gr, Fig. 11, on the lower side of its hub which engages with a pin on the upper side of the slide. Power is delivered from the shaft, F, through a feed shaft having universal joint connections to allow for the lateral movement of the slide, R.

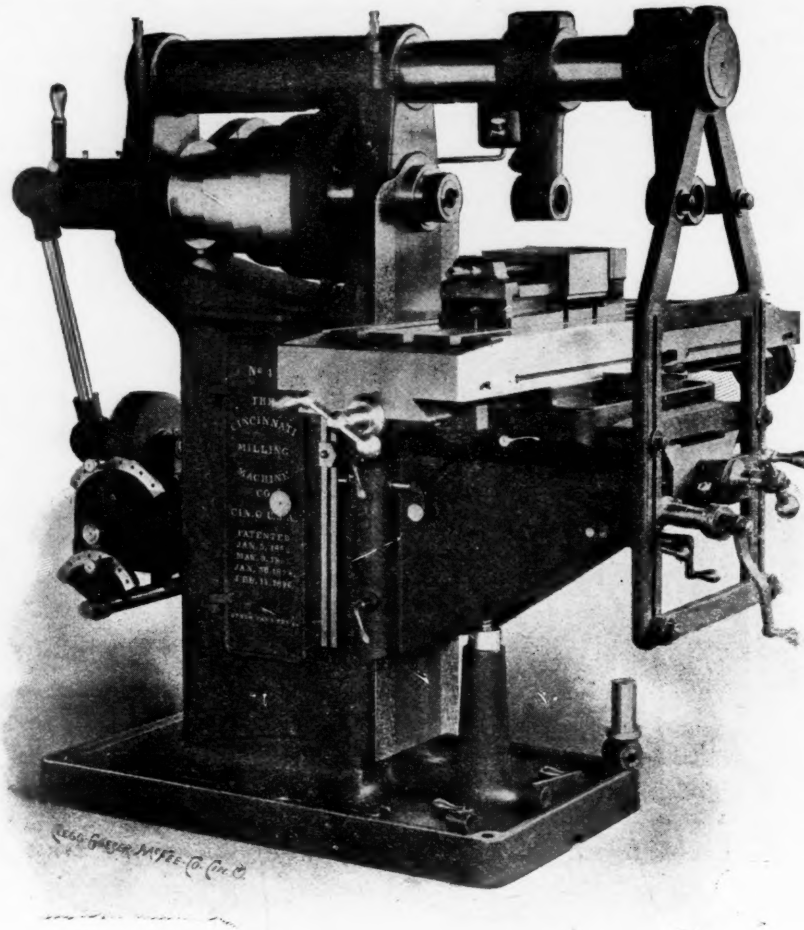


FIG. 12.—VIEW OF THE NO. 4 CINCINNATI MILLING MACHINE.

Fig. 12 is a general view of the No. 4 universal Cincinnati miller with this gear mechanism applied, the two-speed mechanism being above and the eight-speed mechanism below at the rear. It is so arranged that all levers may be operated from the front, but above all the extreme economy of space, occupied by the complete mechanism for such a variation of 16 speeds possible, is to be noted; since the lower mechanism is capable of delivering eight different speeds, and the upper device may deliver two different speeds to it, the combined mechanism is capable of furnishing 16 different speeds: This device has the paramount advantage of having both of the gear mechanisms entirely closed and thus protected from dirt and injury. It is quite as simple in construction as the devices heretofore mentioned and involves no serious difficulties in its manipulation; while in the manner of design it gives evidence of the application of a great amount of ingenuity and is one of the best examples of applied mechanism to be found among the devices of this type.

REMARKABLE LOCOMOTIVE PERFORMANCE.

MICHIGAN CENTRAL RAILROAD.

In recording the fast run of 118 miles in 127 minutes of a heavy passenger train on the Michigan Central in the January number, page 33, the grades were not given. From the elevations of the terminals there is a total rise of 242 ft. in 118 miles, an average grade of 2 ft. per mile against the train. The profile of the road received from Mr. Bronner shows the grade to be a nearly steady rise, with no difficult hills and no opportunities for spurts on down grades. The steepest grade is 21.1 ft. per mile for a distance of only ⅓ mile. Most of the grades are under 10 ft. per mile.

AT THE TICKET WINDOW.

"When does the next train that stops at McAllisterville leave here?"

"You'll have to wait four hours."

"I think not."

"Well, maybe you know better than I do, ma'am."

"Yes, sir, and maybe you know better than I do whether I am expecting to travel on that train myself, or whether I am inquiring for a relative that's visiting at my house and wanted me to call here and ask about it and save her the trouble because she's packing up her things and expects to take that train herself, and not me, and she will have to do the waiting, and not me, and maybe you think it's your business to stand behind there and try to instruct people about things they know as well as you do, if not better; but my idea is that you're put there because they couldn't use you in the switching department, and perhaps you'll learn some day to give people civil answers when they ask you civil questions; young man, my opinion is, you won't!"

(With a gasp) "Yes, ma'am!"—*Railroad Men.*

CORRESPONDENCE.

COMPARISONS OF LOCOMOTIVES.

To the Editor of the AMERICAN ENGINEER:

As an accurate, convenient and simple basis for the comparison of the steaming capacity of both single-expansion and compound locomotives of all types, I beg to submit the following ratio:

$$\frac{\text{Square feet of total heating surface}}{\text{Maximum available tractive force}} \times 100;$$

or, the total heating surface in per cent. of the net tractive effort.

This expression contains all the factors necessary for a complete statement of the case, namely: the boiler pressure, the diameter and stroke of piston, the diameter of the driving wheels, and the heating surface; and it includes no terms which are taken or specially calculated for purposes of comparison. It requires no mathematical reasoning to demonstrate the obvious fact that for any given locomotive, whether simple or compound, the greater the heating surface in proportion to the maximum tractive force, the greater will be the steaming capacity of the engine, and vice versa; hence the above expression is a complete and accurate measure of the steaming power of all classes of locomotives, under all conditions of service.

Furthermore, by solving the foregoing expression for a number of recent and successful locomotives of different types, and tabulating the results, a mass of data can be readily obtained which will prove of value as a guide in future designing. For example, assume that experience has shown that for single-expansion, heavy, fast passenger locomotives, burning bituminous coal, a total heating surface equal to about 15.2 per cent. of the maximum available tractive force results in satisfactory steaming, and that it is desired to obtain this ratio in a new design of express locomotive whose maximum tractive power is, let us say, 23,222 lbs. Then the required heating surface is $0.152 \times 23{,}222 = 3{,}530$ sq. ft; which figures agree very closely with the dimensions of the 4—4—2 type express locomotive, whose remarkable performance on the Michigan Central Railroad was set forth on page 33 of the January (1903) issue of the AMERICAN ENGINEER.

After careful thought it appears to me that the above expression is worthy of serious consideration as a standard method for the comparisons of the steaming capacity of both simple and compound locomotives, the selection of which standard of comparison has been much discussed of late in the technical press.

EDWARD L. COSTER,
A. M. Am. Soc. M. E.

25 Broad Street, New York, January 20, 1903.

THE SHOP AS A SCHOOL.

To the Editor:

Referring to your editorial on page 312 of the October number, in my opinion No. 1 is the man that will get on top, for with my experience I find that the man who covers the ground in three years that you have outlined is not fit for a master mechanic. He should be president of some of our transcontinental railway lines. I do not know of a single man, nor have I ever heard of one, doing it all in three years. I agree with Mr. R. D. Smith, superintendent of motive power of the Burlington & Missouri River Railroad, that it would take a wonderful young man to thoroughly fill all the places that he passed through in the three years.

In the first place, if he were a good boiler-washer, he would do his work so well that not more than one foreman in a hundred would give him anything better, because it would be hard to fill his place washing boilers. More good men are kept down in railroad shops because their places are too hard to fill than for anything else. I know a good lathe hand who would make a good foreman, but on a lathe he is turning out more work than two ordinary men, consequently he is kept there, while if he were placed in charge of the shop, in three years he might be master mechanic. This man may have push but no pull, yet he cannot go to the master mechanic and say, "I am the man you are looking for." Nine chances in ten, he would be discharged on the spot.

You often hear a great cry about men being afraid to speak up for fear of losing their positions; then, on the other hand, if he does speak up and say he does not care for his job, the man over him will say "indifference." Professor Randolph, from the Virginia Polytechnic Institute, hits the nail on the head when he says, "Every man has a chance to rise." In fact, he has to have it if he works in one of our modern railway shops. There is no room for a lazy man around a railway shop. Why? He would get run over.

Going back to the head of the question, "Which is the man?" I rather like No. 1, if he goes at it right, even if he is sent after a "bucket of blast," "half-round squares," "Johnson bars" and "red-lamp oil." He is in position to get what he came for, and if he does not get it, it is his own fault. Of course, he does not get the practical experience handling men, but if a man has it in him to rule or handle men, I think it does not take long to develop this faculty, and also that of knowing what to do at the proper time.

I have known more special apprentices to rise in the mechanical world than men starting as helpers and working up. If I wanted to become a locomotive engineer, I would start helping; but, on the other hand, if I wanted to become a master mechanic, I would start in as an apprentice and then finish out each detail until I had finished, then be open for engagement.

D. G. CUNNINGHAM,
A., T. & S. F. Ry. Roundhouse Foreman, Needles, Col.

To the Editor:

The question of "The Shop as a School" has been closely followed and with much interest. However, but one side has been presented, and I beg to bring to attention a few facts from the other point of view.

In beginning, let me enter a third contestant, C, in the race between A and B. He may or may not have had a technical or even university education, but he is the lucky son of capital or position, by virtue of which he is endowed with what is known simply as "a big pull." The question now of who wins is too easy, for it's a 100-to-1 shot with no takers that C will be a general manager while A and B are still wearing overalls. This case is not an exaggerated condition at all, but one which confronts A and B in the great majority of cases. How far do we have to look for an exhibition of partiality—what young man who is a "big" man in railroad work got there without "pull"? These conditions are the chief disorganizers and reasons for demoralization—it's the reason B doesn't rise faster and it's what keeps A back a little.

Railroad men of the day should not lose sight of the plain truth that graduates enter railroad work at a great disadvantage as compared with other opportunities. It is a doubtful question whether railroad work offers sufficient inducements for the best fitted students to enter it. As for offering equal advantages, there can be no doubt. It is but necessary to compare for a moment the prospects of a young man void of "pull" in railroad work and in other fields. The former means long hours in one of the poorest places to live, very small pay to start with and for years to come, slow promotion and the hardest kind of work On the other hand, manufacturing and commercial concerns offer generally the advantages of a city, better salaries to start with and unquestionably larger and more frequent increases, shorter hours, and a wider range for the practice of the profession chosen. Is it any wonder that the young graduate turns to the brightest prospects and puts his energies where, even in the beginning, he can feel sure of getting some reward?

It is a fact that young men—graduates of technical schools—to-day consider railroads as affording the poorest field of any mechanical line. The writer, meeting a college friend not long ago (whose father before his death was a well-known motive-power man), was asked what he was doing. "Working for a railroad," was the reply, and instantly came the brotherly advice in the questioning form, "Why don't you quit it?" Another acquaintance who after college was also graduated from the apprentice course of one of the larger roads, was asked why he left railroad work, and forthwith the truthful answer came, "No money or promotion in it." A graduate of ten years' experience has lately been made electrical engineer of a 7,000-mile road at a salary that wouldn't pay his way through college. Another graduate of less than three years has been sent abroad by a manufacturing company at a nearly equal salary. These examples are *bona fide*, no "pull" being in any way present, and to offset them there is a general manager barely 30 years old, son of a president, and two division superintendents of about the same age who also have fathers. The writer at the time of his graduation was informed by those sup-

posed to be in charge that it would take two years to reach his name on the waiting list of applicants for admission to the apprentice course of a certain railroad's shops. In just about that time a newspaper, under the caption "Sons of Millionaires Build Engines," made a target of several who graduated one and two years after I did. The son of the superintendent of a locomotive works who refused me a job in the shops is now ready to enter the field, and will be watched with some interest in his efforts.

In conclusion, and speaking for those to come, as well as for the present employees, the writer suggests a pointer which if better regulated would certainly increase the efforts and temptations of those in railroad work:

1. A fair field, with no favorites for the positions we are all aiming for.

2. Salaries equal to those which can be obtained from other concerns, offering, besides shorter hours, less night work and an opportunity to see something of life other than the passing of the "limited express" twice a day.

3. Assurance that there is always room at the top, which it should be understood is a height not a million miles off and which is unencumbered by a lot of healthy men at present.

G. W. C.

To the Editor:

In fairness to both men under consideration, and to best realize what each accomplishes in three years, I will consider them to a slight extent in detail, and quote portions from the original where desirable.

Judging from what the second man accomplished in the roundhouse, he must have remained there about one year. At the beginning of the second year, I will assume, he enters the shop. In that year he eats at the table with the men, lives among them, understands them thoroughly, gains the friendship and respect of men and bosses, becomes the best man in the gang, and is selected for gang foreman and fills the position successfully—in one year.

With no actual previous training, he enters the machine shop, is started on eccentric straps, and in spite of the jealousy of the men and discourageemnt from the foreman, in less than a year, probably nine months, he is not only appointed assistant foreman, but is holding the position successfully. In the other three months of the year he is firing a locomotive and holding his own with the rest. A record of progress in one year even excelling that of his second year. Sub-foreman, we might say, of roundhouse, gang foreman of erecting shop, assistant foreman of machine shop, and locomotive fireman—in three years. It is small wonder he is popularly considered the best man—"Because he is painted so."

And what of the other fellow of *assumed* equal ability who has spent three years in the shop? Has he not gained the respect and friendship of the men and bosses? If he has not—and the article infers this—he is not of equal ability with the second. Has he in three years gained nothing but "a general insight into shop practices"? Then he is not of equal ability with the second. Is the best that can be said, "He does very well"? The article also says, "He ought to be prepared for a position of responsibility, if he has profited by his opportunities," qualifying a praise by suggesting the contrary. Farther, the article says, "The shop is modified to suit the first, and the officers of the road do him homage." This is cited as a strong point against him, and yet in reading the article it seems that the shop is more modified to suit the second man, and I think it reacts more to his credit than otherwise; and yet the original suggests the moral, "It is a disadvantage to cultivate the good will of one's superiors."

The popular view that No. 2 is the better man is not surprising. He *is* the better man, "Because he is painted so." The hypothesis that the men are of equal abilitv, equal mental and physical skill, seems in the article to have been entirely lost sight of. No. 2 is an exceptional man and will succeed, as he has thus far succeeded, in whatever he undertakes. No. 1 has been unattractively painted, and has evidently accomplished little of value to himself or to the company.

In conclusion, I claim that the original supposition has by no means been carried out, for with equal ability and mental skill or tact they will both find their level as surely as water unrestrained will find its level, and they will rise side by side until the character and personal attributes of one gain for him some especial and well-merited reward. F. E. SEELEY.

To the Editor:

As it has not been so very long since I was a special apprentice myself, I have read with interest your editorial in the October number and the replies thereto in the November number, comparing the work and value of a special apprentice with those of another technical young man who goes alone into the shop and, according to the story, wins on his merits.

It seems to me that man No. 1 is practically ignored and the whole article focused on man No. 2, who is certainly a prodigy for accomplishing all the things he is credited with in the time allowed him—three years. Suppose you take the smartest young man graduated from the best technical school in the country and let him enter the boiler-washing gang in some roundhouse, being entirely unknown to the officials of the mechanical department. Do you believe that in a few months he will have improved the methods of boiler washing to such an extent that his ability will be noticed and make him foreman of the gang? Again, he goes into the erecting shop and in less than a year has overcome prejudice of foreman and men, learned all that is necessary to know in order to become a gang boss—a five to ten years' job for an ordinary man—and has become a gang boss, being placed over good, capable men of ten to twenty years' experience! Does this seem probable? Again, he goes into the machine shop as a lathe hand and is soon offered the position of assistant foreman, having presumably worked his way around to all the various machines and mastered them all, else he would not be competent to direct the work of others. After this last achievement he goes to firing, and is soon a regular member of the freight pool—all of this inside of three years.

It seems to me that anyone thinking this matter over thoughtfully cannot help but come to the conclusion that it would be impossible for any man to accomplish in three years what man No. 2 was credited with doing.

In regard to the statement that special apprentices are given special privileges and led to believe that they are being trained for official positions and are "The Coming It," as Mr. Whyte expressed it, I would like to say a word, viz., that in the shop in which I worked the special apprentice had no special privileges, the regular apprentice being moved around from one kind of work to another with the same regularity as was the special apprentice, and worked in the same departments. The only "special privilege" the special apprentice had over his less fortunate brother was the privilege of saving money for "the company" by running hard road tests at the rate of $35 per month, when otherwise they would have had a $100 or $125 engineer of tests.

In regard to the idea that the special apprentice is given to believing himself the coming railroad official, I would say that where I "served my time" we were given to understand that our semi-contract with the railroad company ended in three years. At that time, if we had proved of value to the company, we would be retained, and promoted as opportunity and our abilities permitted. It seems to me that a man who has spent four years in a technical school, is from 23 to 24 years of age, and is willing to spend three years in a railroad shop, starting in at 12½ cents per hour, all for the sake of the experience he will obtain, should be credited with more sense than to believe that all he had to do to become an official was to pass three years in a railroad shop.

W. S. R.

AN IMPROVED KNUCKLE PIN FOR PASSENGER COUPLERS.

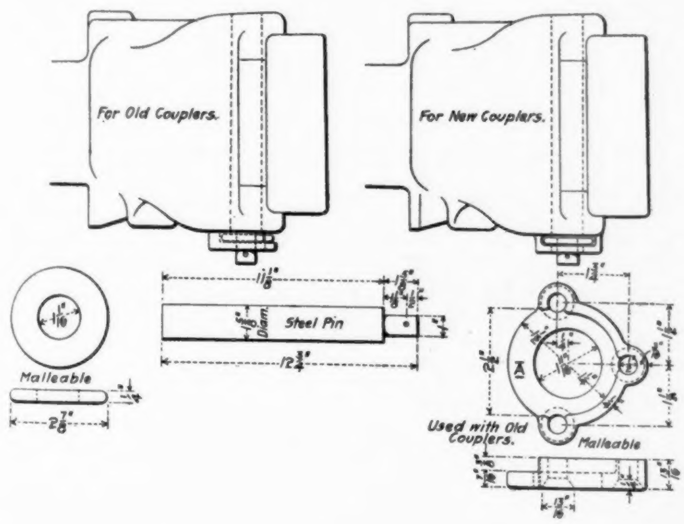
MICHIGAN CENTRAL RAILROAD.

The difficulty met with in removing and replacing knuckles and knuckle-pins of passenger couplers is a serious one on account of the buffers overlapping the pins to such an extent that the pins cannot be removed without first in some way compressing the buffers, removing them, or by taking down the couplers.

A knuckle-pin for passenger couplers, so constructed that it could be as easily and quickly removed as with freight couplers, has been, up to the present time, an unsolved problem. One, however, meeting all requirements, that will commend itself to railroad men generally, and to car men in particular, simple in construction and operation, inexpensive, and that

does not change existing conditions, has been devised on the Michigan Central Railroad and is already in use on many cars. This simple device is so clearly illustrated in the accompanying engraving that little remains to be said in the way of explanation.

The pin is made without a head in order to permit its movement downward through the coupler-head. Its lower end is reduced in size below that of the body, thus forming what may for convenience's sake be called a pintle. A detachable support, or washer, with a hole through its center just sufficiently large to receive the pintle end, furnishes a support for the pin; this, in turn, is carried by another and fixed support, cast on or fastened to the under side of the lower lug, cored out in such a manner as to provide a seat for the detachable support, hold it in position, and permit of its being inserted or removed at will. Through this fixed support is a hole of the full size of the pin, through which the pin may pass freely to and from the coupler when the detachable support, or washer, is removed. As will be readily seen, when in place the pin rests on, and its weight is carried by, the detachable support, which, in turn, is held in place by the fixed one. To remove the pin, it is raised until the pintle end is clear of the movable support.



KNUCKLE PIN SUPPORT FOR PASSENGER COUPLERS.

This support is then taken from its seat out through the slot in the side of the fixed support, which leaves the passage clear for the downward removal of the pin. In replacing, the reverse of this operation is, of course, followed.

For couplers already in use, provision is made for the headless pin by making the fixed support as a separate piece and fastening it to the coupler by means of machine bolts. This method has proven very satisfactory. The engraving shows the device as applied to old and also to new couplers.

In freight couplers there is no advantage in headless pins, nor in removing them from the under side; but there is a great advantage, in both passenger and freight, in having the pins supported at the lower end instead of at the upper, which will hold in place the lower end or piece of pins that often break in service, invariably resulting in breaking off the upper lug of the coupler. The loss from this cause is extremely large, as was shown by a paper read before the Western Railway Club at its meeting in Chicago last May; so it can be said that the bottom-supported pin is valuable for both passenger and freight couplers.

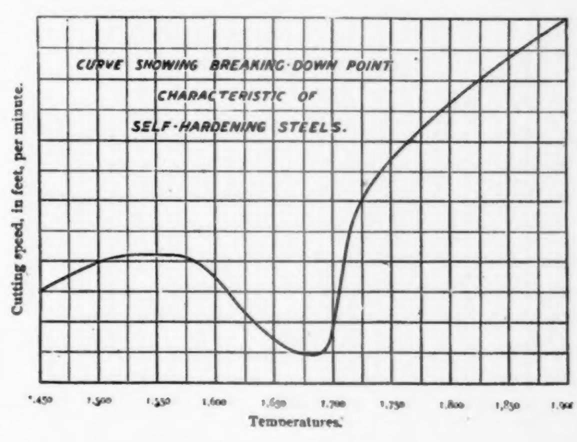
This device is receiving a great deal of attention from railroad men, who invariably speak in favorable terms of its merits. It is the invention of Mr. J. A. Chubb, superintendent of air-brakes of the Michigan Central Railroad.

THE REQUIREMENTS OF MACHINE TOOL OPERATION.

WITH SPECIAL REFERENCE TO THE MOTOR DRIVE.

The tool steel is the keynote to the situation and a complete knowledge of its characteristics and possibilities form the starting point for all further work. Carbon steel will give a finer finish on steel than the air hardening variety and, for form cutters, is still largely used. Where heavy roughing cuts are possible, air hardening steel has unquestionably replaced it and, in fact, the recent developments in the processes of hardening have been the direct means of revolutionizing old methods of machine tool design and so-called shop practice.

We must ever bear in mind that "best shop practice" should mean "arriving at the desired result at the least cost" and can be used in a relative sense only. We constantly hear machinists condemn a means of arriving at a result irrespective of its merits, their reason being that "it is not good practice." If drilling with a feed of 1-16 of an inch per revolution gives the desired finish in much less time, it is certainly good practice and if, under these conditions, we find a sharp point on the drill is not essential, so much the better. Twist drills are



BREAKING-DOWN POINT OF STEELS.

now run from four to six times as fast as used to be considered possible.

The influence of the Taylor-White process tool steel has been so revolutionary in character that it merits dwelling upon it. The underlying principle of this discovery is clearly shown on the accompanying curve, which is plotted from values of cutting speeds and temperatures. It will be seen that this curve rises from the zero point until the temperature of 1550 degrees is reached, when the cutting values suddenly fall off, this representing the full extent of our knowledge, when the experiments at Bethlehem were undertaken. The most interesting and valuable fact, that these values again increase if the hardening temperature is carried beyond the "breaking down points," was the result of the work just referred to, and the superiority of steel treated in this way as compared with Sheffield Mushett—which was probably equal to any air-hardening steel on the market at that time, may be expressed as follows:

	Mushett.	Taylor-White.
10 C Steel	1.0	2.2
30 C Steel	1.0	3.5
Cast Iron	1.0	1.3

These figures are the result of a series of tests conducted by the Franklin Institute and represent the facts as nearly as they could be determined. There are now a number of makes of steel in the market treated along the lines explained above, which give equally as good results.

An exact knowledge of the cutting speeds of which these tools will permit when machining different materials, and the

power to pull various cuts under all conditions, are absolutely essential if we wish to properly design machine tools or use them to their full capabilities in actual service. The value of this information is now being realized by several of the machine tool builders and the results are already being felt in the shop in the form of much more efficient tools.

The motor drive makes the measurement of power so simple that we may arrive at these results with comparatively little difficulty. A series of experiments was recently conducted in the shops of the Link-Belt Engineering Co. to determine the best air hardening tool steel for use on cast iron, using a specially arranged testing lathe and the necessary accessories. This particular lathe gives 126 spindle speeds increasing in 5 per cent. increments and is especially adapted to this work. It is a 48-in. Lodge & Shipley lathe with its motor controller operated from the carriage; it has 42 speeds ahead and six reserve, in a range of 6 to 1. Electrical instruments were used to take records of the energy absorbed and the cutting speeds were carefully determined by suitable instruments.

The accompanying table is a portion of a record and shows the method of tabulating this data. One hundred and twenty-five tests on various tools were made in this series of experiments, the depth of cut and feed being kept constant and the speed varied so that the tool would last just twenty minutes.

TESTS OF TOOL STEELS.

November 24, 1902.

Cast Iron.
Cutting, Dry.

Tool—1¾ in.x⅞ ins.

Kind of Steel in Tool, Self-Hardening
Kind of Tool, Right Hand Roughing.
Clearance Angle of Tool, 8 Degrees.
Rake Angle of Tool { Front 2 Deg's. / Side 20 Deg s.

Experiment Number	Feed.	Depth of Cut.	Cutting Speed in Feet per minute.	Mark on Tool.	Duration of Cut in minute.	Diam. at Top of Cut in inches.	Diam. at Bottom of Cut in inches.	Tool started from Top end in inches.	Volts.	Amperes.	Total Longitudinal Feed of Tool in inches.	Remarks
24	.0606	3/16	97. 91.7	Taylor White H. S. H. No. 1.	16¼	21⅜	21	0	130 131	30 5	16⅛	RUINED.
25	.0606	3/16	103. 100.	Capitol No. 1.	20	21⅜	21	16⅛	170 172	24 5	21¾	FAIR.
26	.0606	3/16	105. 104.	Capitol No. 2,	20	21⅜	21	37⅞	71 172	4 5	$22\frac{11}{16}$	GOOD.
27	.0606	3/16	194. 101.	Capitol No. 3.	13	21	20⅝	0	167 170	27 5	14½	RUINED.
28	.0606	3/16	104. 101	Taylor White No 1. T. W.	11¼	21	20⅝	14½	164 172	26 5	12½	RUINED.
29	0606	3/16	100. 99.1	Jessop No. 1.	20	21	20⅝	27	132 135	26 5	20⅞	GOOD.
30	.0606	3/16	105. 101.	Jessop No. 2.	20	20⅝	20¼	0	166 167	24 5	$22\frac{11}{16}$	RUINED.
31	.0606	3/16	107. 197.5	Jessop No. 1.	20	20⅝	20¼	$22\frac{11}{16}$	168 170	24 5	23	GOOD.
32	0606	3/16	115.5 111.5	Jessop No. 4.	13	20⅝	20¼	$45\frac{11}{16}$	168 170	25 5	16¼	GOOD.
33	.0606	3/16	125. 115.	Jessop No. 3.	$2\frac{1}{12}$	20¼	19⅞	0	166 170	28 5	2¾	RUINED.
34	.0606	3/16	118. 109.	Jessop No. 2.	10¾	20¼	19⅞	2¾	167 170	28 5	$13\frac{3}{16}$	RUINED.
35	.0606	3/16										

A few experiments only would prove of little value, as the factors are so variable in character. The uniformity of the tool must be determined, then the cutting speed for material of all kinds, and finally the relations between these quantities should be ascertained and empirical formulæ derived.

With the present light on the subject, it seems strange indeed how machine tools could have been designed in the past, and it is not strange that we can now criticise the course pursued. We do feel, however, that the manufacturers of such apparatus are slow in adopting the proper course, although in every instance we have found them open to conviction and glad to discuss the problem from the present standpoint.

It is not now my intention to discuss the subject of machine tool design, but I do wish to say that the most inefficient part of most shops is the machine tool equipment, and until the user of this apparatus realizes this point and demands machines designed along the correct lines the desired result will not be reached.

To those who have not given the subject close study this statement may seem to be without foundation, but it matters not what type of tool we consider, its shortcomings can be readily pointed out. The feeds on the average drill press are ridiculously low, the power supplied and rigidity of the frame on machines using multiple cutters are out of all proportion to the work we should be able to absorb at the cut, and so on.

The foregoing paragraphs were selected, as of unusual interest to the users of machine tools, from an admirable paper delivered recently before the New York Electrical Society by Mr. Charles Day, of the firm of Dodge & Day, Philadelphia, Pa. His paper is an excellent treatment of this important subject and we heartily recommend our readers to secure complete copies of the paper for further study, which may be obtained from the secretary of the society, Mr. Geo. H. Guy, 114 Liberty street, New York City.

Mr. T. S. Lloyd, superintendent of motive power of the Delaware, Lackawanna & Western, has been given charge of the car department upon the retirement of Mr. L. T. Canfield from railroad service. Thus another independent car department is placed under the direction of motive-power officers. Mr. Lloyd has in two years put the locomotive department of this road into excellent condition, and the able management of Mr. Canfield has brought the car department to a plane which will render it easy to conduct the two in one office. The high esteem in which Mr. Canfield is held by his former associates was manifested by a large gathering of his friends on the occasion of his leaving his office and the unexpected presentation of beautiful and appropriate tokens. His ability and efficiency as an officer are accompanied by unusual personal traits which make his subordinates and associates his friends; in fact his relations with his subordinates constitute no small part of the reason for his success. Mr. Canfield is now vice-president of the Standard Railway Equipment Company, of St. Louis. Mr. Lloyd has reorganized the car-department official staff to suit the new conditions and has extended the jurisdiction of the various mechanical officers over the car department. Mr. Lloyd was educated at the Western University, near Pittsburgh, and was an apprentice at the Pittsburgh Locomotive Works. After serving as machinist in a number of railroad shops he was made foreman at Fort Wayne, under Mr. F. D. Casanave. In 1890 he went to the Chesapeake & Ohio, as master mechanic of the Cincinnati division, and was promoted to the position of general mechanic at Richmond. The present addition to his responsibilities is one for which he is admirably prepared.

AMERICAN ENGINEER TESTS.

LOCOMOTIVE DRAFT APPLIANCES.

XIII.

Report by Prof. W. F. M. Goss.

SECTION V.

(Continued from Page 362, December, 1902.)

Editor's Note.—This portion of the report includes Tables VI. to XIII., inclusive. Next month we shall proceed with the text.

TABLE VI.

TWENTY-MILE SERIES.

CONSTANTS.

Speed	Miles Per Hour	20
	R. P. M.	97.2
Pounds of Steam Used	Per Hour	8090
	Per Minute	135
Cut Off	In Inches	5.8
	In Per Cent. of Stroke	23.8

M. E. P. 63 lbs.

RESULTS.

I. Stack.	II. Nozzle.	III. Observed. Back Pressure, lbs.	IV. Smoke Box Pressure. Inches of Water, Observed.	V. Smoke Box Pressure. Pounds, Calculated.	VI. Efficiency.
Base No. 1	1	1.2	.8	.028	.024
	2	1.23	.9	.0324	.026
	3				
	4	1.2	1.	.036	.05
	5	1.1	.8	.028	.026
	6	1.3	.8	.0288	.022
	7	1.5	1.	.036	.024
1-A	1	1.20	1.0	.036	.030
	2	1.25	1.2	.043	.034
	3	1.25	1.	.036	.029
	4	1.25	1.2	.043	.04
	5	1.12	1.3	.0468	.042
	6	1.3	1.3	.0468	.036
	7	1.4	1.	.036	.026
1-B	1	1.4	1.0	.036	.026
	2	1.25	1.1	.0396	.032
	3	1.32	1.	.036	.027
	4	1.	1.1	.0396	.04
	5	1.1	1.2	.0432	.039
	6	1.3	1.3	.0468	.036
	7	1.35	1.3	.0468	.035
1-C	1	1.25	1.0	.036	.029
	2	1.25	1.1	.0396	.032
	3	1.25	.9	.0324	.026
	4	1.2	1.2	.043	.036
	5	1.11	1.2	.0432	.034
	6	1.2	1.3	.0468	.039
	7	1.45	1.4	.0503	.035
1-D	1	1.2	.9	.032	.027
	2	1.24	.9	.0324	.026
	3	1.28	1.25	.045	.035
	4	1.1	1.2	.0432	.039
	5	1.09	1.3	.0468	.043
	6	1.3	1.5	.054	.042
	7	1.25	1.5	.054	.043
2-A	1	1.1	1.7	.028	.055
	2	1.25	1.6	.0576	.046
	3	1.26	1.6	.0578	.046
	4	1.2	1.8	.0648	.054
	5	1.15	1.6	.0576	.050
	6	1.3	1.4	.050	.038
	7	1.35	1.3	.0468	.035
2-B	1	1.1	2.3	.083	.075
	2	1.25	2.2	.0792	.063
	3	1.23	2.	.072	.059
	4	1.2	2.3	.0828	.069
	5	1.2	2.3	.0828	.069
	6	1.3	2.	.072	.055
	7	1.25	1.7	.0612	.048
2-C	1	1.05	2.4	.086	.083
	2	1.15	2.4	.0864	.075
	3	1.24	2.7	.0972	.078
	4	1.2	2.6	.0936	.078
	5	1.11	2.4	.0864	.078
	6	1.3	2.4	.0864	.066
	7	1.3	2.1	.076	.058
2D	1	1.1	2.7	.097	.088
	2	1.1	2.7	.097	.088
	3	1.25	2.8	.1008	.081
	4	1.2	3.	.108	.090
	5	1.10	2.9	.1044	.095
	6	1.2	2.6	.0936	.078
	7	1.2	2.2	.0792	.065
Base No. 2	1				
	2	1.2	1.4	.0504	.042
	3				
	4	1.2	1.3	.047	.039
	5	1.06	1.1	.04	.037
	6	1.4	1.	.036	.026
	7	1.2	.6	.022	.018
3-A	1	1.1	1.4	.05	.046
	2	1.2	1.8	.0648	.05
	3	1.2	1.95	.070	.058
	4	1.2	1.8	.065	.054
	5	1.09	1.6	.058	.053
	6	1.3	1.7	.061	.047
	7	1.25	1.2	.043	.035
3-B	1	1.2	1.6	.057	.047
	2	1.23	2.	.072	.058
	3	1.25	2.	.072	.057
	4	1.2	1.9	.068	.057
	5	1.1	2.	.072	.065
	6	1.3	2.	.072	.055
	7	1.4	2.	.072	.051
3-C	1	1.1	1.6	.057	.052
	2	1.22	1.9	.0684	.056
	3	1.19	2.	.072	.060
	4	1.2	2.	.072	.06
	5	1.1	2.3	.088	.075
	6	1.2	2.1	.076	.063
	7	1.25	2.4	.086	.069
3-D	1	1.45	1.3	.046	.038
	2	1.22	1.9	.0684	.056
	3	1.2	2.	.072	.06
	4	1.2	2.	.072	.06
	5	1.05	2.4	.086	.083
	6	1.2	2.3	.083	.069
	7	1.2	2.5	.090	.075
4-A	1	1.3	1.9	.068	.053
	2	1.17	2.5	.09	.077
	3	1.22	2.1	.076	.062
	4	1.2	2.0	.072	.060
	5	1.16	1.8	.065	.056
	6	1.20	1.6	.058	.048
	7	1.40	1.1	.040	.028
4-B	1	1:3	2.3	.083	.063
	2	1.13	2.7	.0972	.086
	3	1.20	2.4	.086	.072
	4	1.25	2.4	.085	.069
	5	1.19	2.5	.090	.076
	6	1.2	2.0	.072	.060
	7	1.25	1.5	.054	.043
4-C	1	1.3	2.6	.094	.072
	2	1.15	2.9	.1042	.091
	3	1.15	2.9	.104	.091
	4	1.2	2.8	.100	.084
	5	1.2	2.7	.097	.081
	6	1.3	2.4	.086	.066
	7	1.35	2.2	.079	.059
4-D	1	1.2	2.9	.104	.087
	2	1.17	3.3	.1188	.102
	3	1.19	3.0	.108	.090
	4	1.2	3.0	.108	.09
	5	1.3	3.1	.112	.086
	6	1.2	3.0	.108	.090
	7	1.2	2.3	.083	.069
Base No. 3	1				
	2	1.2	1.9	.0684	.057
	3				
	4	1.1	1.5	.054	.048
	5				
	6	1.35	.8	.0288	.021
	7	1.35	.50	.018	.013
5A	1	1.12	2.0	.072	.064
	2	1.27	2.4	.0864	.068
	3	1.23	2.0	.072	.058
	4	1.2	1.9	.0684	.057
	5	1.14	1.9	.0684	.06
	6	1.25	1.4	.0504	.04
	7	1.45	1.2	.0432	.03
5-B	1	1.13	2.	.072	.064
	2	1.3	2.7	.0972	.075
	3	1.24	2.2	.0792	.064
	4	1.2	2.4	.0864	.072
	5	1.14	2.2	.0792	.07
	6	1.35	2.1	.0756	.058
	7	1.35	1.9	.0684	.051
5-C	1	1.12	2.1	.075	.067
	2	1.21	2.4	.0864	.072
	3	1.25	2.4	.0865	.069
	4	1.15	2.5	.090	.078
	5	1.11	2.6	.0936	.084
	6	1.25	2.4	.0864	.069
	7	1.3	2.1	.0756	.058
5-D	1	1.12	2.2	.079	.071
	2	1.18	2.4	.0864	.073
	3	1.21	2.7	.0972	.080
	4	1.2	2.7	.0972	.081
	5	1.10	3.0	.108	.098
	6	1.3	2.7	.0972	.075
	7	1.35	2.8	.1008	.075
6-A	1	1.12	2.2	.079	.07
	2	1.21	2.4	.0864	.071
	3	1.1	2.2	.0792	.072
	4	1.3	2.	.072	.055
	5	1.11	1.6	.0576	.052
	6	1.25	1.4	.0504	.04
	7	1.35	1.	.036	.027
6-B	1	1.2	2.6	.093	.078
	2	1.2	2.8	.1008	.084
	3	1.2	2.7	.0972	.081
	4	1.2	2.3	.0828	.069
	5	1.13	2.1	.0756	.067
	6	1.3	1.8	.0649	.05
	7	1.25	1.4	.0504	.04
6-C	1	1.2	3.	.108	.09
	2	1.17	3.	.108	.092
	3	1.2	3.	.108	.09
	4	1.2	2.6	.0936	.078
	5	1.11	2.6	.0936	.084
	6	1.3	2.1	.0756	.058
	7	1.15	1.7	.0612	.058
6-D	1	1.2	3.3	.119	.099
	2	1.14	3.1	.1116	.097
	3	1.2	3.1	.1116	.092
	4	1.4	3.1	.1116	.08
	5	1.11	2.7	.0972	.088
	6	1.2	2.3	.0828	.069
	7	1.3	2.2	.0792	.061
Base No. 4	1				
	2	1.23	1.9	.068	.055
	3				
	4	1.25	1.2	.043	.035
	5				
	6	1.35	.6	.021	.016
	7	1.30	.4	.014	.012
7-A	1	1.14	2.1	.076	.066
	2	1.23	2.3	.082	.067
	3	1.17	2.	.072	.061
	4	1.2	1.8	.064	.054
	5	1.18	1.4	.05	.043
	6	1.2	1.1	.039	.032
	7	1.35	.9	.032	.024
7-B	1	1.14	2.3	.083	.072
	2	1.2	2.7	.097	.081
	3	1.17	2.4	.086	.073
	4	1.25	2.3	.082	.066
	5	1.12	2.2	.079	.071
	6	1.25	1.7	.061	.049
	7	1.15	1.5	.054	.047
7-C	1	1.17	2.6	.094	.08
	2	1.25	2.9	.104	.083
	3	1.23	2.6	.093	.076
	4	1.2	2.5	.09	.075
	5	1.11	2.5	.09	.081
	6	1.3	2.3	.082	.064
	7	1.2	1.9	.068	.056
7-D	1	1.09	2.4	.086	.079
	2	1.3	3.4	.122	.094
	3	1.3	3.2	.115	.088
	4	1.25	2.8	.1	.081
	5	1.11	2.9	.104	.094
	6	1.25	2.6	.093	.075
	7	1.2	2.4	.086	.07
8-A	1	1.1	2.4	.086	.07
	2	1.2	2.4	.086	.072
	3	1.25	2.2	.079	.063
	4	1.25	1.7	.061	.049
	5	1.13	1.4	.050	.045
	6	1.4	1.	.036	.026
	7	1.2	.6	.021	.017
8-B	1	1.2	2.8	.1	.083
	2	1.23	2.6	.093	.076
	3	1.2	2.4	.086	.08
	4	1.25	2.	.072	.058
	5	1.12	2.	.072	.064
	6	1.3	1.4	.050	.039
	7	1.25	1.	.036	.029
8-C	1	1.13	2.8	.1	.089
	2	1.15	2.9	.104	.091
	3	1.18	2.6	.093	.077
	4	1.2	2.3	.082	.069
	5	1.1	2.	.072	.065
	6	1.3	1.7	.061	.047
	7	1.3	1.4	.05	.039
8-D	1	1.15	2.9	.104	.09
	2	1.18	3.1	.111	.094
	3	1.1	3.0	.108	.098
	4	1.2	2.6	.093	.078
	5	1.2	2.4	.086	.072
	6	1.2	2.	.072	.06
	7	1.3	1.6	.057	.043
Normal, Petticoat Pipe In	*	1.2	2.9		
Normal, Petticoat Pipe Out	*	1.4	2.6	.093	.066
Sliding A	1	1.4	2.4	.086	.061
	2	1.3	2.1	.075	.057
	3	1.3	2.0	.072	.055
Sliding B	1	1.5	2.2	.079	.054
	2	1.2	2.4	.086	.071
	3	1.4	2.5	.09	.064
Sliding C	1	1.2	2.6	.093	.077
	2	1.2	2.8	.101	.084
	3	1.2	2.6	.093	.077
Sliding D	1	1.2	2.8	.1008	.084
	2	1.2	2.6	.093	.077
	3	1.3	3.	.108	.09

* Normal.

TABLE VII.

THIRTY-MILE SERIES.

M. E. P. 55.6 lbs.

CONSTANTS.

Speed	Miles Per Hour	30
	R. P. M.	145.8
Pounds of Steam Used	Per Hour	10548
	Per Minute	175
Cut-Off	In Inches	6.
	In Per Cent. of Stroke	25.3

RESULTS.

I. Stack.	II. Nozzle.	III. Observed Back Pressure, lbs.	IV. Smoke Box Pressure. Inches of Water, Observed.	V. Smoke Box Pressure. Pounds, Calculated.	VI. Efficiency.
Base No. 1	1	1.85	.75	.027	.015
	2	1.65	.9	.036	.022
	3				
	4	1.8	1.1	.0396	.022
	5	1.63	1.8	.036	.022
	6	1.8	1.8	.036	.02
	7	1.8	1.1	.0396	.022
1-A	1	1.75	1.25	.036	.021
	2	1.75	1.25	.045	.026
	3	1.79	1.3	.0468	.026
	4	1.8	1.4	.0504	.028
	5	1.64	1.4	.0504	.037
	6	1.8	1.4	.0503	.028
	7	1.9	1.2	.0433	.023
1-B	1	1.6	.9	.032	.02
	2	1.7	1.2	.0432	.025
	3	1.84	1.2	.0432	.023
	4	1.5	1.5	.0546	.036
	5	1.63	1.6	.0576	.035
	6	1.8	1.6	.0576	.032
	7	1.8	1.6	.0576	.032
1-C	1	1.9	1.	.036	.019
	2	1.65	1.1	.0396	.024
	3	1.82	1.2	.0432	.024
	4	1.7	1.4	.05	.03
	5	1.65	1.5	.054	.033
	6	1.8	1.6	.0576	.032
	7	1.7	1.8	.0649	.038
1-D	1	1.9	1.	.036	.019
	2	1.62	1.1	.0396	.024
	3	1.8	1.2	.0432	.024
	4	1.7	1.5	.054	.032
	5	1.63	1.6	.0576	.035
	6	1.7	1.8	.0648	.038
	7	1.5	1.8	.0649	.043
2-A	1	1.85	1.8	.065	.036
	2	1.65	2.	.072	.044
	3	1.79	2.	.072	.04
	4	1.6	2.1	.076	.047
	5	1.65	1.8	.065	.039
	6	1.8	1.6	.058	.032
	7	1.85	1.4	.050	.027
2-B	1	1.9	2.5	.09	.047
	2	1.67	2.7	.0972	.058
	3	1.77	2.6	.0936	.053
	4	1.8	2.8	.1008	.056
	5	1.65	2.6	.0936	.057
	6	1.8	2.2	.0792	.044
	7	1.8	1.9	.0684	.038
2-C	1	1.7	2.9	.104	.061
	2	1.62	3.2	.1152	.071
	3	1.8	3.1	.1116	.062
	4	1.6	3.	.108	.067
	5	1.62	3.	.108	.067
	6	1.7	2.7	.0972	.057
	7	1.75	2.4	.0865	.049
2-D	1	1.8	3.1	.111	.062
	2	1.53	3.6	.1296	.085
	3	1.84	3.55	.128	.07
	4	1.8	3.5	.126	.07
	5	1.63	3.2	.1152	.071
	6	1.8	3.	.108	.06
	7	1.8	2.8	.1008	.056
Base No. 2	1				
	2	1.67	1.7	.0612	.037
	3				
	4	1.7	1.6	.058	.034
	5	1.62	1.4	.05	.031
	6	1.8	1.1	.039	.022
	7	1.8	.8	.029	.016
3-A	1	1.8	1.8	.065	.036
	2	1.72	2.	.072	.042
	3	1.75	2.2	.079	.045
	4	1.8	2.2	.079	.044
	5	1.65	2.	.072	.044
	6	1.8	1.8	.065	.036
	7	1.8	1.5	.054	.03
3-B	1	1.85	1.8	.064	.035
	2	1.74	2.2	.0792	.045
	3	1.65	2.2	.079	.048
	4	1.6	2.4	.086	.054
	5	1.6	2.4	.086	.054
	6	1.8	2.2	.079	.044
	7	1.9	2.1	.076	.039
3-C	1	1.8	1.9	.068	.038
	2	1.72	2.2	.0792	.046
	3	1.77	2.4	.086	.048
	4	1.7	2.55	.092	.054
	5	1.65	2.6	.094	.057
	6	1.8	2.6	.094	.052
	7	1.8	2.5	.09	.05
3-D	1	1.8	2.	.072	.040
	2	1.63	2.1	.0756	.046
	3	1.67	2.3	.082	.049
	4	1.6	2.5	.09	.056
	5	1.62	2.8	.101	.062
	6	1.8	2.7	.097	.054
	7	1.8	2.7	.097	.054
4-A	1	1.8	2.5	.090	.05
	2	1.7	2.9	.1042	.061
	3	1.75	2.6	.096	.053
	4	1.6	2.5	.09	.056
	5	1.63	2.2	.079	.049
	6	1.7	1.8	.065	.038
	7	1.85	1.3	.047	.025
4-B	1	1.9	3.1	.112	.059
	2	1.7	3.4	.122	.072
	3	1.75	3.1	.1116	.063
	4	1.65	3.	.108	.066
	5	1.65	2.8	.101	.061
	6	1.6	2.3	.083	.052
	7	1.95	1.9	.068	.035
4-C	1	1.8	3.4	.122	.064
	2	1.63	3.9	.1402	.086
	3	1.75	3.6	.130	.074
	4	1.65	3.3	.118	.071
	5	1.67	3.2	.115	.069
	6	1.8	2.8	.101	.056
	7	1.8	2.3	.083	.046
4-D	1	1.9	3.9	.140	.074
	2	1.67	4.3	.1548	.093
	3	1.73	3.8	.137	.079
	4	1.7	3.6	.129	.076
	5	1.7	3.6	.129	.076
	6	1.8	3.4	.122	.067
	7	1.8	2.8	.101	.056
Base No. 3	1				
	2	1.7	2.2	.0792	.0466
	3				
	4	1.9	1.6	.0576	.031
	5				
	6	1.8	.9	.0324	.0179
	7	1.8	.6	.0216	.012
5-A	1	1.7	2.6	.094	.055
	2	1.68	2.7	.0972	.058
	3	1.7	2.6	.0936	.055
	4	1.7	2.3	.0828	.048
	5	1.65	2.1	.0756	.046
	6	1.7	1.7	.0612	.036
	7	1.85	1.3	.0468	.026
5-B	1	1.67	2.6	.094	.056
	2	1.7	3.3	.1188	.07
	3	1.75	2.8	.1008	.057
	4	1.7	2.8	.1008	.059
	5	1.67	2.6	.0936	.056
	6	1.8	2.4	.086	.048
	7	1.8	2.	.072	.04
5-C	1	1.65	2.6	.094	.057
	2	1.65	3.	.108	.065
	3	1.78	3.	.108	.061
	4	1.8	3.2	.1152	.064
	5	1.7	3.	.108	.063
	6	1.7	2.9	.104	.061
	7	1.85	2.5	.094	.049
5-D	1	1.65	2.7	.097	.059
	2	1.65	3.2	.1152	.07
	3	1.75	3.	.108	.062
	4	1.7	3.3	.1188	.07
	5	1.63	3.6	.1296	.08
	6	1.7	3.2	.115	.068
	7	1.95	3.1	.1116	.057
6-A	1	1.62	2.9	.104	.064
	2	1.64	2.9	.1042	.064
	3	1.7	2.8	.1008	.059
	4	1.75	2.3	.0828	.047
	5	1.65	2.	.072	.044
	6	1.8	1.6	.0576	.032
	7	1.8	1.1	.0396	.022
6-B	1	1.6	3.2	.115	.072
	2	1.7	3.5	.126	.074
	3	1.8	3.5	.126	.07
	4	1.7	2.9	.0044	.061
	5	1.63	2.8	.1008	.062
	6	1.7	2.	.072	.042
	7	1.75	1.6	.0576	.033
6-C	1	1.55	3.6	.155	.083
	2	1.73	3.9	.1402	.081
	3	1.8	3.9	.14	.077
	4	1.85	3.3	.1188	.064
	5	1.61	3.	.108	.067
	6	1.8	2.5	.09	.05
	7	1.55	2.1	.0756	.044
6-D	1	1.7	4.3	.155	.091
	2	1.7	4.	.144	.085
	3	1.6	4.	.144	.09
	4	1.95	3.8	.1368	.07
	5	1.6	3.3	.1188	.074
	6	1.7	2.8	.1008	.059
	7	1.85	2.4	.086	.046
Base No. 4	1				
	2	1.68	2.4	.086	.051
	3				
	4	1.65	1.4	.050	.031
	5				
	6	1.8	.7	.025	.014
	7	1.95	.5	.018	.009
7-A	1	1.63	2.9	.104	.064
	2	1.72	3.	.108	.063
	3	1.67	2.5	.09	.054
	4	1.65	2.3	.082	.050
	5	1.65	1.8	.064	.039
	6	1.6	1.4	.050	.031
	7	1.9	1.	.036	.019
7-B	1	1.67	3.	.108	.065
	2	1.7	3.4	.122	.072
	3	1.7	2.9	.104	.061
	4	1.7	2.9	.104	.062
	5	1.63	2.7	.097	.06
	6	1.75	2.1	.075	.043
	7	1.75	1.7	.061	.035
7-C	1	1.62	3.	.108	.067
	2	1.8	3.7	.133	.074
	3	1.8	3.6	.13	.072
	4	1.82	3.2	.115	.063
	5	1.68	3.3	.118	.071
	6	1.75	2.8	.105	.058
	7	1.60	2.3	.083	.052
7-D	1	1.62	3.1	.112	.069
	2	1.9	4.1	.148	.078
	3	1.87	4.0	.144	.077
	4	1.7	3.5	.128	.075
	5	1.68	3.7	.133	.079
	6	1.8	3.2	.115	.064
	7	1.8	2.9	.104	.057
8-A	1	1.65	2.9	.104	.063
	2	1.7	3.0	.108	.063
	3	1.82	2.6	.093	.052
	4	1.7	2.	.072	.042
	5	1.65	1.5	.054	.033
	6	1.8	1.1	.039	.022
	7	1.85	.8	.028	.015
8-B	1	1.67	3.2	.115	.069
	2	1.67	3.3	.118	.071
	3	1.72	3.	.108	.063
	4	1.5	2.4	.086	.057
	5	2.1	2.2	.079	.038
	6	1.95	1.7	.061	.031
	7	1.8	1.2	.043	.024
8-C	1	1.69	3.6	.129	.076
	2	1.63	3.6	.129	.08
	3	1.8	3.6	.130	.072
	4	1.6	2.8	.10	.063
	5	2.3	2.8	.1	.043
	6	1.9	2.1	.075	.04
	7	1.75	1.6	.057	.033
8-D	1	1.8	4.	.144	.08
	2	1.8	4.	.144	.08
	3	1.8	4.	.144	.08
	4	1.7	3.	.108	.063
	5	2.3	3.3	.118	.043
	6	1.8	2.4	.086	.047
	7	1.85	1.9	.068	.037
Normal, Petticoat Pipe In	*	1.8	2.8	.1	.055
Normal, Petticoat Pipe Out	*	1.8	3.2	.115	.064
Sliding A	1	2.1	2.8	.101	.04
	2	1.7	2.7	.097	.057
	3	1.9	2.3	.082	.043
Sliding B	1	1.9	2.6	.093	.049
	2	1.7	3.	.108	.063
	3	1.9	2.8	.101	.053
Sliding C	1	2.	3.2	.115	.057
	2	1.6	3.4	.122	.076
	3	2.	3.2	.115	.057
Sliding D	1	1.8	3.3	.119	.066
	2	1.6	3.4	.122	.076
	3	1.8	3.4	.122	.068

* Normal.

TABLE VIII.

FORTY-MILE SERIES.

CONSTANTS.

Speed	Miles Per Hour	40
	R. P. M.	194.4
Pounds of Steam Used	Per Hour	12988
	Per Minute	216
Cut off	In Inches	6.4
	In Per Cent. of Stroke	26.9

M. E. P. 52.0 lbs.

RESULTS.

I. Stack.	II. Nozzle.	III. Observed Back Pressure, lbs.	IV. Smoke Box Pressure. Inches of Water, Observed.	V. Smoke Box Pressure. Pounds, Calculated.	VI. Efficiency.
Base No. 1	1	2.7	1.2	.043	.016
	2	2.24	1.2	.0432	.019
	3				
	4	2.25	1.3	.0468	.021
	5	2.25	1.2	.0432	.019
	6	2.4	1.2	.0432	.018
	7	2.55	1.	.036	.014
1-A	1	2.3	1.2	.043	.019
	2	2.25	1.4	.0504	.022
	3	2.50	1.6	.0577	.023
	4	2.3	1.7	.061	.027
	5	2.22	1.7	.0612	.028
	6	2.2	1.7	.0612	.028
	7	2.45	1.5	.054	.022
1-B	1	2.2	1.4	.05	.023
	2	2.3	1.4	.0504	.022
	3	2.35	1.4	.0503	.021
	4	2.25	1.8	.065	.029
	5	2.21	1.9	.0684	.031
	6	2.4	1.9	.0684	.028
	7	2.25	1.9	.0684	.03
1-C	1	2.65	1.4	.05	.018
	2	2.23	1.4	.0504	.023
	3	2.52	1.4	.0503	.02
	4	2.05	1.7	.0612	.03
	5	2.13	1.8	.0648	.03
	6	2.2	1.9	.0684	.031
	7	2.4	2.	.072	.03
1-D	1	2.45	1.3	.047	.019
	2	2.25	1.4	.0504	.022
	3	2.4	1.4	.0503	.021
	4	2.3	1.8	.0648	.028
	5	2.22	1.9	.0684	.031
	6	2.2	2.	.072	.033
	7	2.3	2.1	.0756	.033
2-A	1	2.6	2.3	.083	.032
	2	2.27	2.4	.0864	.038
	3	2.35	2.6	.0936	.04
	4	2.	2.4	.0864	.043
	5	2.21	2.2	.0792	.036
	6	2.4	2.	.072	.03
	7	2.45	1.6	.0578	.024
2-B	1	2.4	3.1	.111	.046
	2	2.2	3.2	.1152	.052
	3	2.37	3.3	.1188	.05
	4	2.2	3.	.108	.049
	5	2.25	2.9	.1044	.046
	6	2.4	2.5	.09	.037
	7	2.4	2.2	.0792	.033
2-C	1	2.45	3.5	.126	.051
	2	2.15	3.8	.1368	.064
	3	2.38	3.7	.1332	.056
	4	2.3	3.5	.126	.055
	5	2.25	3.5	.126	.056
	6	2.2	3.1	.1116	.051
	7	2.2	2.7	.0972	.044
2-D	1	2.45	4.	.144	.059
	2	2.1	4.3	.1548	.074
	3	2.42	4.	.144	.059
	4	2.4	3.9	.1404	.058
	5	2.21	4.	.144	.065
	6	2.4	3.4	.122	.051
	7	2.25	3.2	.1152	.051
Base No. 2	1				
	2	2.33	2.1	.0756	.032
	3				
	4	2.3	1.9	.068	.030
	5	2.22	1.6	.058	.026
	6	2.2	1.2	.043	.019
	7	2.5	.9	.032	.013
3-A	1	2.6	2.3	.082	.032
	2	2.4	2.6	.094	.039
	3	2.4	2.65	.096	.039
	4	2.2	2.6	.094	.043
	5	2.23	2.4	.086	.038
	6	2.2	2.1	.076	.034
	7	2.5	1.7	.061	.025
3-B	1	2.5	2.7	.097	.039
	2	2.3	2.6	.094	.041
	3	2.5	2.9	.104	.042
	4	2.3	2.9	.104	.045
	5	2.25	2.9	.104	.046
	6	2.2	2.6	.094	.043
	7	2.65	2.4	.087	.033
3-C	1	2.5	2.7	.097	.038
	2	2.27	2.8	.1008	.044
	3	2.34	2.7	.097	.045
	4	2.3	3.1	.112	.049
	5	2.23	3.1	.112	.05
	6	2.3	3.	.108	.047
	7	2.4	2.8	.101	.042
3-D	1	2.6	2.4	.086	.033
	2	2.23	2.7	.0972	.044
	3	2.6	3.	.108	.041
	4	2.4	3.	.108	.045
	5	2.2	3.	.108	.049
	6	2.2	3.1	.112	.051
	7	2.4	3.2	.115	.048
4-A	1	2.3	.3	.108	.047
	2	2.3	3.3	.1188	.052
	3	2.35	3.	.108	.046
	4	2.2	2.9	.104	.047
	5	2.3	2.5	.09	.039
	6	2.2	2.	.072	.033
	7	2.4	1.4	.05	.021
4-B	1	2.2	3.5	.126	.057
	2	2.35	4.1	.1476	.063
	3	2.34	3.4	.122	.052
	4	2.25	3.6	.130	.058
	5	2.27	3.2	.152	.051
	6	2.4	2.7	.097	.041
	7	2.6	2.1	.076	.029
4-C	1	2.5	4.3	.155	.062
	2	2.3	4.6	.1656	.072
	3	2.28	4.	.144	.063
	4	2.3	4.	.144	.063
	5	2.34	3.7	.133	.057
	6	2.4	3.	.108	.045
	7	2.3	2.6	.094	.041
4-D	1	2.8	5.3	.191	.068
	2	2.27	5.	.18	.079
	3	2.41	4.4	.158	.065
	4	2.4	4.3	.155	.065
	5	2.4	4.2	.151	.063
	6	2.4	3.8	.136	.057
	7	2.35	3.2	.115	.049
Base No. 3	1				
	2	2.35	2.8	.1008	.043
	3				
	4	2.45	1.9	.0684	.028
	5				
	6	2.45	1.1	.0396	.016
	7	2.25	.7	.0252	.011
5-A	1	2.41	3.2	.115	.048
	2	2.33	3.5	.126	.054
	3	2.4	3.1	.1116	.046
	4	2.4	2.8	.1008	.042
	5	2.25	2.4	.0864	.038
	6	2.2	2.	.072	.033
	7	2.35	1.4	.0503	.021
5-B	1	2.37	3.2	.115	.049
	2	2.4	3.9	.1402	.058
	3	2.36	3.4	.1221	.052
	4	2.45	3.2	.1152	.047
	5	2.25	3.2	.1152	.051
	6	2.3	2.8	.1008	.044
	7	2.4	2.8	.0792	.033
5-C	1	2.3	3.2	.115	.05
	2	2.25	3.6	.1296	.058
	3	2.4	3.6	.130	.054
	4	2.4	3.7	.1332	.055
	5	2.25	3.6	.1296	.057
	6	2.25	3.4	.122	.054
	7	2.4	3.1	.1116	.046
5-D	1	2.45	3.4	.122	.05
	2	2.26	3.8	.1368	.059
	3	2.3	3.6	.13	.056
	4	2.45	4.	.144	.054
	5	2.22	3.9	.1404	.063
	6	2.3	3.8	.1368	.059
	7	2.35	3.5	.126	.054
6-A	1	2.4	3.6	.129	.054
	2	2.3	3.5	.126	.055
	3	2.2	3.4	.122	.055
	4	2.45	2.7	.0972	.04
	5	2.28	2.4	.0864	.036
	6	2.4	1.8	.0648	.027
	7	2.4	1.3	.0468	.019
6-B	1	2.27	4.	.144	.064
	2	2.33	4.2	.151	.065
	3	2.2	4.2	.151	.068
	4	2.3	3.4	.1224	.053
	5	2.24	3.	.108	.048
	6	2.15	2.4	.086	.040
	7	2.25	1.9	.0684	.030
6-C	1	2.1	4.4	.158	.075
	2	2.26	4.6	.1656	.073
	3	2.2	4.5	.162	.074
	4	2.35	3.9	.1404	.06
	5	2.27	3.4	.1224	.056
	6	2.2	2.9	.104	.047
	7	2.25	2.4	.0684	.038
6-D	1	2.1	4.8	.173	.082
	2	2.25	5.	.18	.08
	3	2.3	5.2	.1872	.081
	4	2.4	4.4	.1584	.066
	5	2.2	4.1	.1476	.067
	6	2.25	3.3	.1188	.053
	7	2.5	2.8	.1008	.04
Base No. 4	1				
	2	2.30	2.8	.1	.043
	3				
	4	2.3	1.7	.061	.027
	5				
	6	2.3	.75	.027	.012
	7	2.35	.5	.018	.008
7-A	1	2.22	3.4	.122	.055
	2	2.35	3.6	.129	.055
	3	2.13	3.	.108	.051
	4	2.33	2.7	.097	.042
	5	2.25	2.4	.086	.038
	6	2.3	1.6	.057	.025
	7	2.3	1.1	.039	.017
7-B	1	2.18	3.6	.129	.059
	2	2.25	4.2	.158	.07
	3	2.30	3.6	.130	.056
	4	2.4	3.4	.122	.051
	5	2.22	3.	.108	.049
	6	2.2	2.4	.086	.039
	7	2.2	1.9	.068	.031
7-C	1	2.21	3.6	.129	.058
	2	2.35	4.6	.166	.071
	3	2.37	4.	.144	.061
	4	2.35	3.8	.136	.058
	5	2.22	3.8	.136	.062
	6	2.3	3.2	.1156	.05
	7	2.45	2.9	.104	.043
7-D	1	2.21	3.9	.14	.067
	2	2.4	4.7	.169	.070
	3	2.3	4.2	.151	.066
	4	2.2	4.2	.151	.069
	5	2.25	4.2	.151	.067
	6	2.35	3.7	.133	.057
	7	2.35	3.5	.126	.054
8-A	1	2.22	3.5	.126	.057
	2	2.3	3.6	.129	.056
	3	2.4	3.	.108	.045
	4	2.35	2.3	.082	.035
	5	2.33	1.9	.068	.029
	6	2.30	1.25	.045	.02
	7	2.35	.9	.032	.014
8-B	1	2.25	4.1	.148	.066
	2	2.4	4.2	.151	.063
	3	2.45	3.5	.126	.051
	4	2.35	2.9	.104	.045
	5	2.5	2.4	.086	.035
	6	2.4	1.9	.068	.028
	7	2.25	1.4	.05	.022
8-C	1	1.27	4.5	.162	.071
	2	2.25	4.4	.158	.07
	3	2.4	4.	.144	.06
	4	2.25	3.4	.122	.054
	5	2.7	3.	.108	.037
	6	2.4	2.4	.086	.036
	7	2.2	1.9	.068	.031
8-D	1	2.4	4.9	.176	.073
	2	2.23	4.7	.169	.075
	3	2.4	4.2	.151	.069
	4	2.4	3.6	.130	.054
	5	2.8	3.6	.129	.036
	6	2.4	2.7	.097	.04
	7	2.25	2.3	.082	.036
Normal, Petticoat Pipe In	*	2.4	3.9	.14	.058
Normal, Petticoat Pipe Out	*	2.4	3.8	.136	.057
Sliding A	1	2.8	3.6	.129	.046
	2	2.2	3.	.108	.049
	3	2.3	2.7	.097	.042
Sliding B	1	2.6	3.0	.108	.041
	2	2.2	3.4	.122	.055
	3	2.3	3.1	.111	.048
Sliding C	1	2.6	3.5	.126	.048
	2	2.3	3.9	.140	.061
	3	2.5	4.2	.151	.06
Sliding D	1	2.4	4.0	.144	.06
	2	2.2	4.1	.147	.067
	3	2.4	4.0	.144	.06

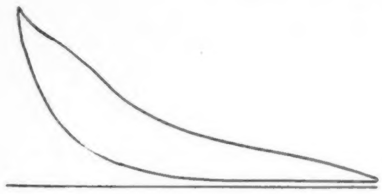
* Normal.

TABLE IX.

FIFTY-MILE SERIES.

CONSTANTS.

Speed	Miles per hour	50
	R. P. M.	243
Pounds of Steam Used	Per Hour	14194
	Per Minute	236
Cut-Off	In Inches	6.8
	In Per Cent. of Stroke	28.5



M. E. P. 41.5 lbs.

RESULTS.

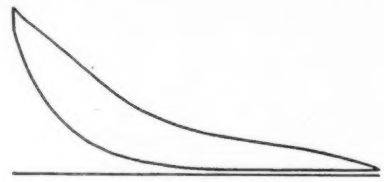
I.	II.	III.	IV.	V.	VI.
			Smoke Box Pressure.		
Stack.	Nozzle.	Observed Back Pressure, Pounds.	Inches of Water, Observed.	Pounds, Calculated.	Efficiency.
2-B	1	3.	3.1	.115	.038
	2	2.95	3.1	.115	.038
	3	2.9	3.4	.123	.042
2-C	1	3.	4.	.144	.048
	2	3.1	3.9	.14	.044
	3	2.8	4.	.144	.051
2-D	1	3.5	5.1	.187	.052
	2	3.	4.3	.154	.051
	3	3.1	4.6	.165	.054
4-B	1	2.9	4.2	.151	.053
	2	3.	4.	.144	.046
	3	3.	4.2	.151	.05
4-C	1	3.	4.9	.176	.058
	2	2.9	4.4	.158	.054
	3	2.9	4.2	.151	.052
4-D	1	3.4	5.7	.205	.06
	2	3.	5.	.18	.06
	3	2.8	4.6	.156	.055
6-B	1	2.8	4.6	.165	.059
	2	2.8	3.2	.115	.041
	3	2.7	4.0	.144	.052
6-C	1	2.8	5.1	.183	.063
	2	2.85	4.8	.172	.061
	3	2.7	4.2	.151	.056
6-D	1	2.7	5.4	.194	.069
	2	3.	5.4	.194	.064
	3	2.6	4.6	.165	.063
8-B	1	3.	4.6	.165	.055
	2	3.1	4.3	.154	.05
	3	2.8	3.8	.136	.048
8-C	1	2.8	5.2	.187	.066
	2	3.	4.8	.172	.057
	3	3.	4.	.144	.048
8-D	1	3.	5.5	.198	.066
	2	2.9	5.2	.187	.065
	3	3.2	5.4	.194	.06
Normal Petticoat, Pipe In	Normal	3.	4.6	.165	.055
Normal Petticoat, Pipe Out	Normal	2.8	4.4	.158	.057
Sliding A	1	3.4	4.	.144	.042
	2	2.8	3.5	.126	.045
	3	2.9	3.1	.111	.038
Sliding B	1	3.2	3.6	.129	.04
	2	2.9	3.9	.140	.048
	3	3.	3.6	.129	.043
Sliding C	1	3.1	4.	.144	.046
	2	2.3	3.9	.14	.061
	3	3.4	5.2	.18	.053
Sliding D	1	3.	4.2	.151	.05
	2	2.8	4.6	.165	.059
	3	3.	4.8	.172	.057

TABLE X.

SIXTY-MILE SERIES.

CONSTANTS.

Speed	Miles Per Hour	60
	R. P. M.	291.6
Pounds of Steam Used	Per Hour	15040
	Per Minute	250
Cut-Off	In Inches	7.2
	In Per Cent. of Stroke	30.0



M. E. P. 40.0 lbs.

RESULTS.

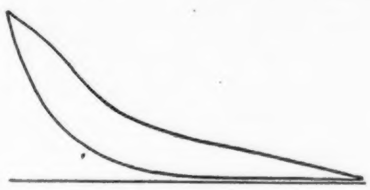
I.	II.	III.	IV.	V.	VI.
			Smoke Box Pressure.		
Stack.	Nozzle.	Observed Back Pressure, Pounds.	Inches of Water, Observed.	Pounds, Calculated.	Efficiency.
2-B.	1	3.6	3.4	.123	.034
	2	3.65	3.6	.129	.034
	3	3.5	3.8	.136	.039
2-C	1	3.5	5.1	.187	.046
	2	3.65	4.4	.158	.042
	3	3.4	4.4	.158	.045
2-D	1	4.2	5.9	.212	.05
	2	3.6	4.8	.172	.047
	3	3.5	4.8	.172	.049
4-B	1	3.5	4.9	.176	.05
	2	3.7	4.4	.158	.042
	3	3.5	4.4	.158	.045
4-C	1	3.1	5.4	.194	.055
	2	3.45	5.	.180	.051
	3	3.2	4.6	.156	.049
4-D	1	3.8	6.7	.241	.064
	2	3.7	6.6	.237	.064
	3	3.4	5.	.180	.052
6-B	1	3.5	5.1	.183	.052
	2	3.5	4.7	.168	.048
	3	3.5	4.2	.151	.043
6-C	1	3.5	5.7	.205	.058
	2	3.25	5.6	.201	.057
	3	3.5	4.8	.172	.05
6-D	1	3.5	6.2	.223	.063
	2	3.5	5.8	.208	.058
	3	3.2	5.2	.187	.059
8-B	1	3.6	5.2	.187	.051
	2	3.5	4.5	.162	.046
	3	3.2	4.	.144	.045
8-C	1	3.4	6.	.216	.063
	2	3.5	5.2	.187	.052
	3	3.6	4.6	.165	.045
8-D	1	3.9	6.4	.236	.06
	2	3.7	6.	.216	.058
	3	3.8	5.6	.201	.052
Normal Petticoat, Pipe In	Normal	3.5	5.2	.187	.053
Normal Petticoat, Pipe Out	Normal	3.2	5.	.180	.056
Sliding A	1	3.8	4.2	.151	.04
	2	3.2	3.8	.136	.042
	3	3.5	3.1	.111	.032
Sliding B	1	3.7	4.	.144	.039
	2	3.8	4.9	.140	.038
	3	3.3	3.9	.140	.042
Sliding C	1	3.4	4.6	.165	.048
	2	3.2	5.1	.183	.057
	3	3.6	5.3	.190	.052
Sliding D	1	3.5	4.8	.173	.049
	2	3.2	5.1	.183	.057
	3	3.5	5.4	.194	.055

TABLE XI.

19 PER CENT. CUT-OFF SERIES.

CONSTANTS.

Cut-Off	In Inches	4.5
	In Per Cent. of Stroke	19
Pounds of Steam Used	Per Hour	9702
	Per Minute	162
Speed	Miles Per Hour	40
	R. P. M.	194.4



M. E. P. 35.4 lbs

RESULTS.

I. Stack.	II. Nozzle.	III. Observed Back Pressure, Pounds.	IV. Smoke Box Pressure. Inches of Water, Observed.	V. Smoke Box Pressure. Pounds, Calculated.	VI. Efficiency.
2-B	1	1.6	1.6	.0576	.036
	2	1.4	1.6	.0576	.041
	3	1.4	2.	.072	.051
2-C	1	1.6	2.	.072	.06
	2	1.4	2.	.072	.051
	3	1.6	2.4	.0864	.054
2-D	1	1.5	2.4	.0864	.058
	2	1.4	2.4	.0864	.062
	3	1.6	2.6	.0936	.058
4-B	1	1.5	2.2	.0792	.053
	2	1.4	2.2	.0792	.057
	3	1.5	2.4	.0864	.058
4-C	1	1.4	2.5	.0738	.053
	2	1.3	2.4	.0864	.066
	3	1.5	2.6	.0936	.062
4-D	1	1.4	3.1	.1116	.079
	2	1.4	2.6	.0936	.067
	3	1.5	2.8	.1008	.067
6-B	1	1.5	2.3	.0828	.055
	2	1.4	2.2	.0792	.056
	3	1.6	2.4	.0864	.054
6-C	1	1.5	3.	.108	.072
	2	1.4	2.6	.0936	.067
	3	1.4	2.6	.0936	.067
6-D	1	1.5	2.9	.1044	.069
	2	1.4	2.4	.0864	.062
	3	1.5	3.	.108	.072
8-B	1	1.2	2.5	.09	.075
	2	1.2	2.2	.0792	.066
	3	1.5	2.2	.0792	.058
8-C	1	1.3	2.7	.0972	.075
	2	1.4	2.6	.0936	.067
	3	1.4	2.4	.0864	.062
8-D	1	1.4	3.2	.1152	.082
	2	1.4	3.6	.1296	.093
	3	1.4	3.	.108	.076
Normal Petticoat, Pipe In	Normal	1.4	2.4	.086	.051
Normal Petticoat, Pipe Out	Normal	1.2	2.4	.086	.072
Sliding A	1	1.4	2.0	.072	.051
	2	1.1	1.9	.068	.062
	3	1.3	1.6	.057	.044
Sliding B	1	1.2	2.	.072	.06
	2	1.4	2.1	.075	.053
	3	1.4	1.9	.068	.048
Sliding C	1	1.2	2.	.072	.06
	2	1.2	2.4	.086	.071
	3	1.2	2.3	.082	.068
Sliding D	1	1.4	2.2	.079	.056
	2	1.3	2.4	.086	.066
	3	1.4	2.3	.082	.058

TABLE XII.

26.9 PER CENT. CUT-OFF SERIES.

CONSTANTS.

Cut-Off	In Inches	6.4
	In Per Cent. of Stroke	26.9
Pounds of Steam Used	Per Hour	12988
	Per Minute	216
Speed	Miles Per Hour	40
	R. P. M.	194.4

M. E. P. 50.1 lbs.

RESULTS.

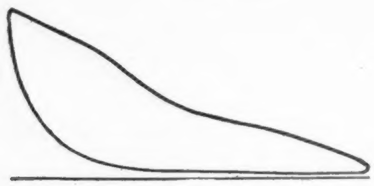
I. Stack.	II. Nozzle.	III. Observed Back Pressure, Pounds.	IV. Smoke Box Pressure. Inches of Water, Observed.	V. Smoke Box Pressure. Pounds, Calculated.	VI. Efficiency.
2-B	1	2.4	2.6	.0936	.039
	2	2.4	2.6	.0936	.039
	3	2.3	3.	.108	.047
2-C	1	2.4	3.2	.1152	.043
	2	2.4	3.2	.1152	.052
	3	2.4	3.5	.1098	.046
2-D	1	2.4	4.2	.1512	.063
	2	2.4	3.8	.1368	.057
	3	2.5	4.4	.1584	.063
4-B	1	2.2	3.5	.1260	.057
	2	2.2	3.4	.1144	.052
	3	2.4	3.6	.1296	.054
4-C	1	2.5	4.3	.1546	.062
	2	2.5	4.	.144	.058
	3	2.5	4.	.144	.058
4-D	1	2.4	5.3	.1908	.079
	2	2.3	4.2	.1512	.066
	3	2.5	4.4	.1584	.063
6-B	1	2.4	3.7	.1322	.055
	2	2.2	3.7	.1332	.06
	3	2.4	3.6	.1296	.054
6-C	1	2.3	4.3	.1548	.067
	2	2.4	4.2	.1512	.063
	3	2.5	4.2	.1512	.065
6-D	1	2.2	4.7	.1692	.077
	2	2.5	4.4	.1584	.061
	3	2.4	4.4	.1584	.066
8-B	1	2.4	4.	.144	.06
	2	2.2	3.8	.1368	.062
	3	2.4	3.4	.1224	.051
8-C	1	2.5	4.6	.1656	.066
	2	2.4	4.2	.1512	.063
	3	2.4	3.8	.1368	.056
8-D	1	2.4	5.	.18	.075
	2	2.6	4.8	.1728	.066
	3	2.4	4.2	.1512	.063
Normal Petticoat, Pipe In	Normal	2.4	3.9	.140	.058
Normal Petticoat, Pipe Out	Normal	2.4	3.8	.136	.057
Sliding A	1	2.3	3.6	.129	.046
	2	2.2	3.	.108	.049
	3	2.3	2.7	.097	.042
Sliding B	1	2.6	3.	.108	.041
	2	2.2	3.4	.122	.055
	3	2.3	3.1	.111	.048
Sliding C	1	2.6	3.5	.126	.048
	2	2.3	3.9	.140	.061
	3	2.5	4.2	.151	.060
Sliding D	1	2.4	4.	.144	.06
	2	2.2	4.1	.147	.067
	3	2.4	4.	.144	.06

TABLE XIII.

35 PER CENT. CUT-OFF SERIES.

CONSTANTS.

Cut-Off	In Inches	8.4
	In Per Cent. of Stroke	35.0
Pounds of Steam Used	Per Hour	17330
	Per Minute	289
Speed	Miles Per Hour	40
	R. P. M.	194.4



M. E. P. 65.4 lbs.

RESULTS.

I. Stack.	II. Nozzle.	III. Observed Back Pressure, Pounds.	IV. Smoke Box Pressure. Inches of Water, Observed.	V. Smoke Box Pressure. Pounds, Calculated.	VI. Efficiency.
2-B	1	4.	4.3	.1548	.038
	2	4.	4.2	.1512	.038
	3	4.	4.6	.1656	.041
2-C	1	4.	5.	.18	.045
	2	4.	5.	.18	.045
	3	4.	5.4	.1944	.048
2-D	1	4.	6.5	.2340	.058
	2	4.	6.	.216	.054
	3	4.3	6.	.216	.05
4-B	1	4.	5.9	.2124	.053
	2	4.2	5.4	.1944	.046
	3	4.3	5.2	.1872	.044
4-C	1	4.	7.	.252	.063
	2	4.1	6.4	.2304	.056
	3	3.9	6.	.216	.055
4-D	1	4.2	7.6	.2736	.065
	2	4.2	6.6	.2376	.054
	3	4.2	6.2	.2232	.053
6-B	1	3.8	6.3	.2268	.059
	2	4.2	6.8	.2448	.058
	3	4.	5.8	.2088	.052
6-C	1	4.	6.7	.2415	.06
	2	3.8	6.9	.2304	.061
	3	4.	6.	.216	.054
6-D	1	3.9	7.6	.2736	.07
	2	4.2	7.4	.2664	.063
	3	4.	7.	.252	.063
8-B	1	4.2	6.6	.2376	.056
	2	4.3	5.9	.2124	.049
	3	3.8	5.	.18	.047
8-C	1	4.2	7.2	.2592	.062
	2	4.	7.	.252	.068
	3	4.	5.8	.2088	.052
8-D	1	4.	7.8	.2808	.07
	2	4.	7.6	.2736	.068
	3	4.	6.4	.2304	.057
Normal Petticoat, Pipe In	Normal	4.	5.7	.202	.051
Normal Petticoat, Pipe Out	Normal	4.	5.8	.208	.052
Sliding A	1	3.9	5.2	.187	.048
	2	4.4	4.8	.172	.039
	3	4.8	4.	.144	.03
Sliding B	1	3.8	5.2	.187	.049
	2	4.2	5.1	.183	.043
	3	4.4	4.9	.176	.04
Sliding C	1	4.	5.7	.205	.051
	2	4.4	6.3	.226	.051
	3	4.7	6.2	.223	.047
Sliding D	1	4.	6.2	.223	.055
	2	4.2	6.2	.223	.053
	3	4.8	6.2	.223	.046

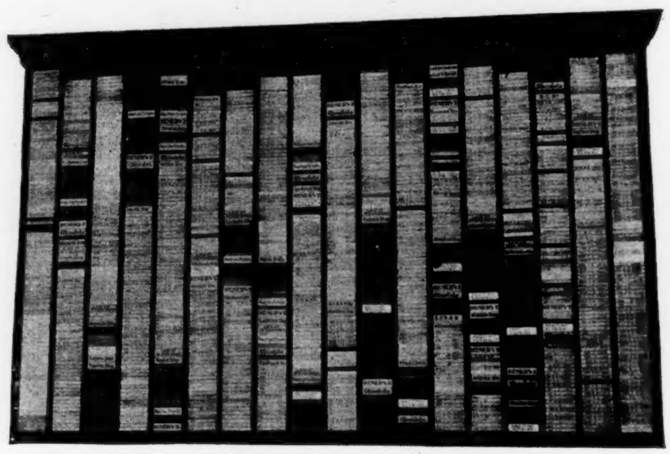
CONVENIENT LOCOMOTIVE RECORD.

DEVISED BY G. R. HENDERSON.

This engraving is from a photograph of a convenient and compact locomotive record in the office of Mr. G. R. Henderson, superintendent of motive power of the Santa Fé. Each locomotive on the road is represented by a block of wood 2 ins. square by ¼ in. thick. On each edge of the block is the engine number, classification and tractive power. Each of the four edges is painted with a color representing the condition of the engine. White signifies "good"; blue, "fair"; green, "poor," and yellow, "awaiting the shop." The blocks are arranged in columns in an open case, where they are easily examined and moved about or turned around. Index blocks, thicker than the others, indicate the various shops or divisions, and the blocks are placed under these indexes as desired. For instance, the block marked

2247 S 14,950

refers to switch engine No. 2247, having a tractive effort of 14,950 lbs. The block may be placed under "Topeka Shop," or "Chicago Division," or "Reserve," or "Scrapped." The color of the edge of the block which is exposed to view indicates its



A CONVENIENT LOCOMOTIVE RECORD.

condition, and its location in the case shows its location on the road. Every month the whole record is revised by a clerk and the "condition" indications brought up to date. Every week the location record is revised. "Good" condition means that the engine will give 90 days or more of efficient service; "fair" means that an engine is good for from 30 to 90 days of service; "poor" means "shop in 30 days."

Mr. Henderson devised this record system while he was with the Chicago & Northwestern, and it is still being used there very satisfactorily. Mr. Henderson has extended it also to the condition of cars. A large case in the car-department office provides blocks for all the passenger cars on the road. There is sufficient space for three years' records, and each column represents a month. The colors of the blocks represent classes of cars, as follows: White, mail; yellow, chair; green, smokers; blue, chair; drab, combination, and pink, dining cars. The four sides of the blocks indicate that a car is in the shop for repairs of one of four classes, according to which side is exposed. These are indicated as follows: Class A, general overhauling and painting, repaneling, or the original paint burned off; class B, general overhauling and painting, without burning off old paint; class C, general overhauling and applying one coat of coach color, re-striping and varnishing; class D, general overhauling, with paint touched up and varnished.

It would seem to be difficult to devise a more elastic, compact and convenient system than this for keeping a record of a large amount of equipment. The case shown in the engraving is about 4 ft. long by 3 ft. high and perhaps 3 ins. deep from the wall. It is a part of an admirable system by which Mr. Henderson may inspect at a glance the condition of his work.

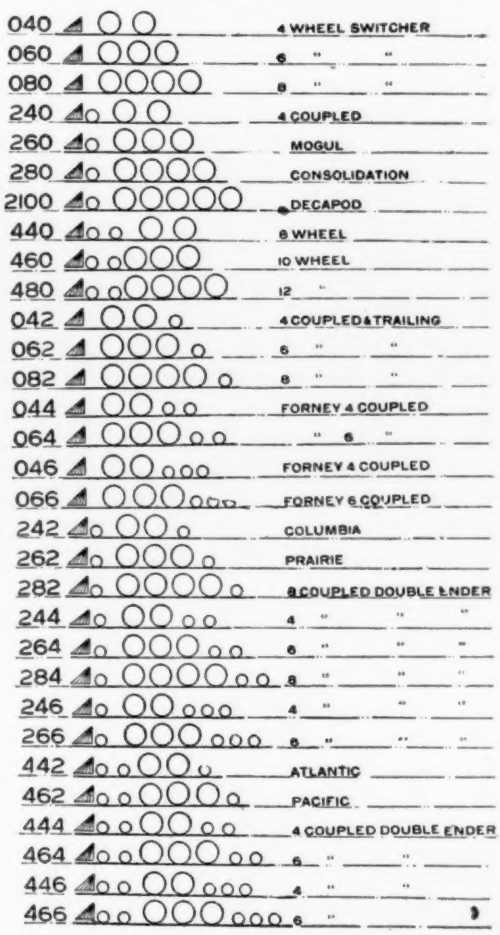
WHYTE'S LOCOMOTIVE CLASSIFICATION.

ADOPTED BY THE AMERICAN LOCOMOTIVE COMPANY.

The engineering department of the American Locomotive Company, under the direction of Mr. J. E. Sague, mechanical engineer, has adopted the Whyte locomotive classification, devised by Mr. F. M. Whyte, of the New York Central, and explained by him on page 56 of this journal for February, 1901.

A plan was desired which would be simple, universal, easily understood and easily used. It is based upon the representation, by numerals, of the number and arrangement of the wheels of a locomotive, beginning at the front. Thus 260 means a "mogul" and 460 a "ten-wheel" engine, the cipher denoting that no trailing wheels are used. These numerals may be separated by hyphens or they may be placed consecutively.

WHYTE'S LOCOMOTIVE CLASSIFICATION.
Adopted by American Locomotive Company.



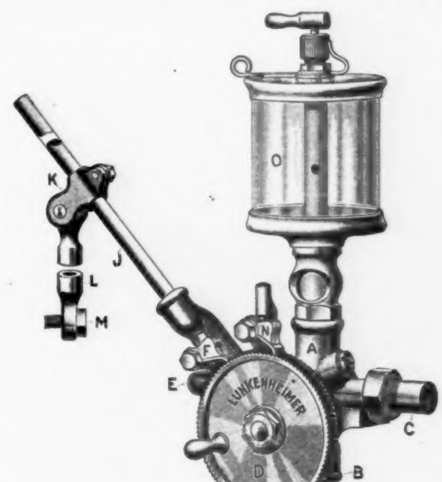
Thus far the classification is merely a substitute for the old method of referring to different wheel arrangements by popular names, a custom which has given us the "Central Atlantic," "Northwestern," "Chautauqua" and "Atlantic" types for the same wheel arrangement. It has also given us the "Pacific," the "Mountain" and "St. Paul" types for another wheel arrangement, with other perplexing nomenclature.

In order to include in the classification some definite factor which will convey an idea of the character and size of a locomotive, the American Locomotive Company adds the total weight of the engine expressed in thousands of pounds. Thus an Atlantic type locomotive weighing 176,000 lbs. will be classed as a 442-176 type. If the locomotive is compound, the letter "C" will be substituted for the hyphen, and the classification will be written 442C176. Locomotives with tanks on the main frames, instead of separate tenders, will be indicated by the letter "T" in place of the hyphen. Thus a double-end suburban locomotive with a two-wheel leading truck, six drivers and a six-wheel rear truck, weighing 214,000 lbs., will be represented by 266T214.

This action of these locomotive builders is to be commended. The accompanying diagram indicates the new beside the old classification.

LUNKENHEIMER MECHANICAL OIL CUP.

A new positive, mechanically operated oil cup has been perfected by the Lunkenheimer Company, of Cincinnati, Ohio. Oil from the glass reservoir is fed to a small pump below, through a sight feed glass, and all the oil which comes down must necessarily be delivered to the desired destination. The pump is driven by the crankpin mechanism (H and G in the engraving) and the piston rod E. A lever (J) is driven by the fittings attached to it, and the ratchet-wheel D is advanced by a certain number of notches, as determined by the stroke, which depends upon the position of the fitting K. The lubricator is mounted upon a stand and placed in a convenient location where it may be driven from the engine, the oil pipe being connected from the tube C to the steam chest or cylinder. A check valve is placed in the oil connection to secure satisfactory working of the device. In starting the engine, if more oil is desired, the ratchet-wheel may be turned by hand. The ratchet-wheel and pawls are of hardened tool steel, all other metal parts being of hard bronze composition.

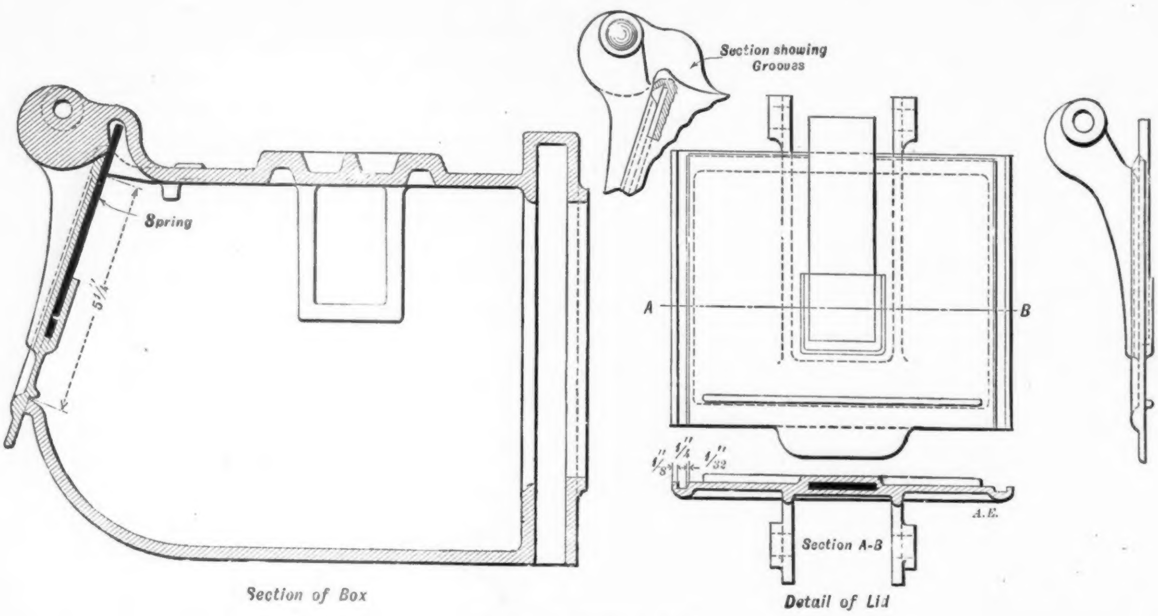


LUNKENHEIMER MECHANICAL OIL CUP.—FRONT VIEW.

Tests at partial and full loads have been made by Prof. Jacobus of Stevens Institute of Technology upon a Rice & Sargent, cross-compound condensing engine at the Brooklyn plant of the American Sugar Refining Company. The engine had 20.03 and 40 by 42-in. cylinders, and the average clearance in the cylinders was 4 per cent for the high pressure and 6.8 per cent for the low pressure. It was provided with a reheating coil in the receiver which was supplied with steam at boiler pressure. The condenser was of the Bulkley pattern and the engine drove a direct connected Bullock generator, the speed being 120 rev. per min. The tests showed a water consumption of 12.10 lbs. per horse-power-hour at 627 horse-power and 12.75 lbs. at 1,004 horse-power. At 491 horse-power the water consumption was 13.9 lbs. and at 339 horse-power it was 14.58 lbs. These figures represent the total water consumption, including that used in the jackets and the reheater coil. The complete record of the tests, including a description of the calibration of the electrical measuring instruments, is continued in a pamphlet issued by the Providence Engineering Works, Providence, R. I.

THE SHARP JOURNAL BOX.

The journal box was designed and patented by Mr. W. E. Sharp, of the Armour car lines, with a view of reducing the amount of trouble from hot boxes. It is constructed with a tight lid, which is held tightly closed by a spring fitted into the lid so that it will press the lid against its seat, and yet when the lid is fully open the spring is out of the way and it may remain open. The spring is straight and is secured by a dovetail bit in the lid itself. The engravings illustrate the fitting of the lid against the projecting top of the box and also the grooves in the cover at the sides. These tend to keep out dust, which is undoubtedly the cause of a large proportion of the hot boxes. To prevent dirt from entering the box at the inside face, the dust guard slot opens on the under side. These boxes have been in service for more than a year, giving satisfactory results. They are manufactured by the Holland Company, 77 Jackson Boulevard, Chicago.



THE SHARP JOURNAL BOX.

EDUCATIONAL DEPARTMENTS OF THE NEW YORK CITY Y. M. C. A.

The educational departments of the various New York City branches of the Young Men's Christian Association have this season met with large enrollments in the classes in which both day and evening instruction is given at convenient hours. Among the subjects taught are the following: Arithmetic; algebra; geometry; free-hand, architectural and mechanical drawing; bookkeeping and commercial law.

The courses of study are all carefully adapted to meet the requirements of those who have not had the opportunity of higher education, but who wish to better themselves by study outside of working hours, and particular care is exercised for the individual wants of each student. A large portion of the enrollment in the mechanical drawing class this year is from the ranks of practical machinists, metal workers, and even tracers from draughting offices, who find the demands of the times to require of them their best efforts. Also many of the students in mechanical drawing are those who have had instruction from correspondence schools with not entirely satisfactory results, and have found it far more desirable to work with the assistance of, and in the presence of, an instructor.

It is of unquestionably far greater advantage to study with an instructor than by the correspondence school method, and we earnestly recommend any one desiring instruction, who can have access to the Y. M. C. A. schools, to avail himself of the same instead of the correspondence method.

The building of the Twenty-third Street Branch, which is the oldest, and the parent of all, has recently been sold, and a new building is now in process of erection on the same street between Seventh and Eighth avenues. It is to cost when completed about $850,000, and will undoubtedly be the most complete association building in the world. In this building class rooms capable of accommodating over 700 students in day and evening classes will be arranged.

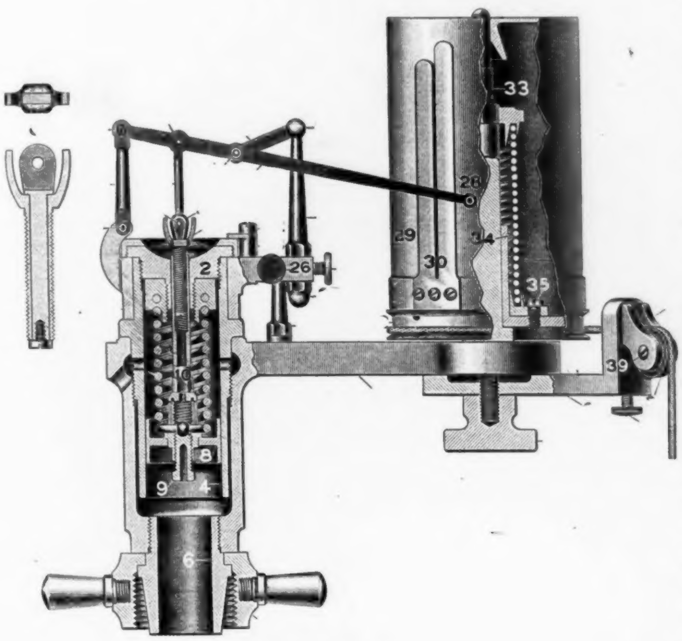
The Vulcan Shipbuilding and Engineering Company, of Germany, builders of the "Kronprinz Wilhelm," the "Kaiser Wilhelm der Grosse" and others of the trans-Atlantic fleet of the North German Llyod Steamship Company, has selected a new location for its shipbuilding yard and works on the River Elbe, near the North Sea. The company has for some time been hampered in constructing and handling the modern mammoth ocean liners at its former works at Stettin, on the River Oder, by the shallow draft of the water in the latter river, as well as in its outlet, the Baltic Sea itself. The intention is, at first, to build only the large vessels at the new works, the engines for the same, and as far as possible the boilers also, to be supplied by the Stettin works.

A remarkably strong recommendation for the chilled cast-iron carwheel comes from the Central Railroad of New Jersey. It appears that out of 8,000 wheels under 1,000 50-ton steel cars built for that road by the Pressed Steel Car Company but 6 wheels were found to be defective in 21 months of continuous service. This amounts to 0.75 of 1 per cent. These and other interesting figures on this subject were presented by Mr. Streicher, of that road, at the February meeting of the New York Railroad Club.

An air-lift pumping plant using the Pohle system of piping and raising water 267 ft. is described in a recent number of *Compressed Air*. The plant is at Grinnell, Iowa, the wells are 2,000 ft. deep and the discharge is at the rate of 136 gals. per minute.

THE STAR IMPROVED STEAM ENGINE INDICATOR.

This instrument combines good features of other instruments of its kind with a number of valuable new ones. Its frame is strong and rigid. The pencil motion is of the well-known Thompson type, which was selected because of its satisafctory features of rigdity and lightness. The spring terminates in a ball, as in all instruments of the Richards type. The cylinder is removable from the frame, and is steam-jacketed to prevent unequal expansion. Instead of screwing into the outer shell, the cap is threaded into the interior of the top of the cylinder itself, thus securing perfect alignment of the piston-rod. A hard rubber covering is secured to the cap, having a milled edge, this material being non-conducting and permitting of handling without the least discomfort. Another feature of this kind is a tube to conduct away the steam and hot water from the top of the cylinder, so that the operator's hand will not be burnt. These conveniences are sure to be appreciated. To adjust the height of the pencil, a threaded swivel head is provided for the piston-rod, and the atmospheric



STAR IMPROVED INDICATOR.

line may be brought to any desired location on the card. This instrument has an improved clutch detent attachment and a helical spring for driving the drum. By a few easily made changes the instrument may be changed from right to left hand. The Star Brass Manufacturing Company, 108 East Dedham street, Boston, are the manufacturers. They are equipped with machinery and have expert mechanics, their indicator department being in all respects upon the high plane of their other well-known specialties.

A profit-sharing plan has been put into effect by the Pressed Steel Car Company for the benefit of its employees. The company will carry for each of its employees who has been in its service six months, and whose application is approved by the general manager, from one to twenty-five shares of the company's preferred stock, according to the wages or salary of the employee. An initial payment of 5 per cent. on the stock must be made, followed by monthly payments of the same amount. As interest on the deferred payments will be charged at only 4 per cent., and the stock pays 7 per cent., the employees have the advantage of the difference of 3 per cent.

CAST-IRON WHEELS AND BRAKESHOES.

"Keep down the braking load and the necessity of much braking effort, and you will help the cast-iron wheel; increase either the speed or load, or both, and the wheels will suffer if they are not proportionately strengthened. For the same amount of braking in the same period of time, I believe that a shoe of soft cast-iron will heat the cast-iron wheel to a less extent than any other shoe in common use, for the reason that considerable heat must be dissipated in the particles which are thrown off the shoe in an incandescent state. Apparently the softer cast iron allows the passage of heat through the body of the shoe, whereas the more ductile, flowing metals, as wrought iron and mild steel, as well as the harder and more dense chilled and hard cast iron, apparently hold back the heat and maintain a higher temperature at the face of the shoe and consequently a higher temperature at the wheel-face. As brakshoe makers, our efforts have been directed toward retaining, as much as possible, the soft cast-iron effect in the brakeshoe, toughening it by inserts to resist rapid wear as well as to increase the grip on the wheel. We have been compelled, however, in order to meet to-day's requirements, to reinforce the cast-iron body by the addition of a steel back as a safeguard against failure in the shoe by cracking. The cast-iron wheel cannot, unfortunately, be reinforced in the same manner as the brakeshoe, and the wheelmakers can only add more weight in the rim and plate and improve the quality of the metal. The records of test on cast-iron wheels under the 80,000-lb. and 100,000-lb. capacity freight cars indicate that the cast-iron wheel of to-day is equal to the increased demand when the braking load is based on the light weight of the car. What will happen to the cast-iron wheel from the brakeshoe acting with a load based on the total weight of the loaded car is a question yet to be decided.

"In conclusion, and returning to the consideration of the cast-iron wheel to meet to-day's requirements from the standpoint of the relation between the brakeshoe and the wheel, the use of a flanged brakeshoe—bearing on the wheel-tread and flange, the shoe supported against failure by a steel back—will materially assist the successful operation of the best cast-iron wheel that can be made."

These are the concluding paragraphs in a paper by Mr. F. W. Sargent, read at the February meeting of the New York Railroad Club. The paper should be carefully read by everyone who is interested in the operation of trains and the maintenance of equipment.

THE ESSENTIALS OF A GOOD DRAFT GEAR.

I. A drawbar of the strongest material to resist blows, jerks, etc., with secure attachment to transmit stresses received.

II. Adequate yielding resistance with minimum recoil, securely housed.

III. Fixed attachments of the car strong and well designed for ease of inspection of the gear, and well secured to the car so as to distribute and dispose of all stresses as advantageously as possible.—Mr. E. M. Herr, in a paper before the Railway Club of Pittsburgh.

BOOKS AND PAMPHLETS.

Locomotives: Simple, Compound and Electric. By H. C. Reagan, Locomotive Engineer. Fourth Edition. 578 pp., Illustrated. John Wiley & Sons, 43 East Nineteenth street, New York. 1902. Price, $2.50.

The author is a locomotive engineer and writes for locomotive engineers and firemen. He describes boilers, cylinders, frames, rods, valve motion, the compound locomotive, safety valves, in-

jectors and boiler fittings, air brakes, and an appendix is devoted to the electric locomotive. With few exceptions, he contents himself with descriptions and does not get down into the important principles. A large amount of the matter is already available from manufacturers' catalogues.

That this book is in its fourth edition indicates that it has had a good reception, but to the reviewer this appears to be for lack of a better book rather than because of great merit in itself. It contains new matter, but does not reflect the most important progress of the locomotive since the appearance of the previous edition. Its value lies chiefly in a presentation of descriptions of various systems of compounding, in suggestions with respect to emergency repairs for cases of breakdown, and in an elementary discussion of electric locomotives, supplemented by engravings of a number of such locomotives. The good features of the book are prominent, but they stand out from a lot of matter much of which is old and indifferently presented. The locomotive is worthy of the best work of which any author is capable, and this book should be revised and completed. It should be brought up to date with respect to present tendencies of design. A lot of obsolete matter should be discarded and present day practice presented in its place. The probable reason why we have no satisfactory book on the locomotive is that in order to be up to date such a work needs to be completely revised every few years. In spite of these criticisms we are glad to see any book upon the locomotive. Engineers and firemen are eager students and faithful readers. They should therefore have the best that can be produced.

History of the Nottingham & Lincoln Railway—a paper by Mr. Clement E. Stretton, of Saxe Coburg House, Leicester, England.—The author traces the history of this road from the incorporation of the Midland Railway in 1844, the line of which was extended, by advice of George Stephenson, to Nottingham and Lincoln. Mr. Stretton is to be commended for his faithfulness in placing on record many portions of the important early history of railroad development which would otherwise be forgotten and concealed by the swift progress of transportation. In connection with the account the author says: "Finally, the Jessop 'edge-rail-way' from Loughborough to Nanpantan was opened in June, 1789, being the first line upon which the inside flanged wheel was used. The fact that Mr. Jessop first decided to have an outside gauge of 5 ft. and then changed to an inside gauge without altering the rails is, of course, the reason why we to-day have a gauge of 4 ft. 8½ ins. In other words, it is 5 ft. less the width of two of Jessop's rails. All modern railway vehicles, it is common knowledge, have a flange upon the inner side, and it is equally certain that without the flange railway traffic would be impossible, as the Outram idea of a ledge upon the rail to keep the wheels upon the track would be useless for other than horse traction, or a speed of more than six or seven miles an hour. Mr. Jessop's great invention was, therefore, in 1788 to introduce and make at the Butterley works the flanged wheel and the edge rail. The fact that William Jessop was the inventor of the flanged wheel, and that he, by placing the flange inside, made the railway gauge 4 ft. 8½ ins., as it is at present, is an interesting point in railway history, and it is pleasing to know that some of the original rails are preserved in the South Kensington Museum, the Leicester Museum and at the Loughborough Free Library.. Thus, at Loughborough originated two most important inventions, viz., the edge railway and the 4 ft. 8½-in. railway gauge, which latter gauge has become almost universal."

Of a large number of calendars received this year from manufacturing concerns, two are worthy of special mention, one from the Brady Brass Company and the other from the American Steam Gauge and Valve Manufacturing Company. Both of these are unusually artistic and attractive.

"Cranes of Different Kinds" is the title of a handsomely printed pamphlet received from Maris Brothers, Philadelphia, builders of hand and electric traveling cranes. In a few pages of well-written description, accompanied by engravings, the reader finds the product of the company, and its purposes, presented with the minimum expenditure of his time and trouble. This pamphlet is from the advertising shop of Clarence P. Day, 140 Nassau street, New York. Its unique character and attractive appearance cannot fail to compel careful examination by those into whose hands it comes.

The board of directors of the Allis-Chalmers Company in a meeting held January 15, declared the regular quarterly dividend on the preferred stock.

Mr. J. W. Duntley, president of the Chicago Pneumatic Tool Company, gave a banquet at the Union League Club, Chicago, January 12, to the representatives of the company in the United States and Canada. It was held at the close of the business meeting on the occasion of the second annual gathering of these representatives in Chicago. Mr. J. W. Duntley received a loving cup and Mr. W. O. Duntley a handsome watch from the representatives of the sales department of the company. In connection with the meeting, a committee of the directors visited all of the plants on a trip of inspection. It was evident that greatly enlarged facilities must be provided to meet the immediate demand for increased product.

The American Blower Company, Detroit, Mich., have distributed an illustrated circular describing the heating plant for the Natural Food Company, Niagara Falls, N. Y., in which the "A. B. C." system is employed. The building is 463 ft. long, and in all has an area of 5½ acres of floor space. The heating system supplies 4,500,000 cu. ft. of volume with a change of air every 15 minutes, and in some portions every 7½ minutes. Three 200-in. steel-plate fans are employed.

The Pedrick & Ayer Company, for a great many years located at Philadelphia, Pa., have removed to Plainfield, N. J., and are now occupying their new works which they have just completed, the main building of which is 400 ft. long and 100 ft. wide, with independent power-house, blacksmith shop, pattern shop and pattern storage. This new shop has been equipped with electric traveling cranes and modern tools so as to enable them to meet the largely increased demand for their standard goods, for which they have made such a reputation, consisting of air compressors, air hoists, pneumatic riveters, and special railroad tools. Their selling office is at 85-87-89 Liberty street, New York City.

The Baldwin Locomotive Works built 1,532 locomotives in the year 1902, 1,375 in 1901 and 1,217 in 1900. The best year prior to 1900 was 1890, with an output of 946 locomotives. Of the 1,532 built last year 74 were electric, 424 were compounds and 25 were fitted to burn oil. The number built for export was 99. Owing to the demand at home the number exported was very much smaller than usual.

The Phosphor-Bronze Smelting Company (Limited), 2200 Washington avenue, Philadelphia, have issued a newly revised price list, No. 21, of their well-known "Elephant Brand" phosphor-bronze. It is stated that this company is constantly adding to and improving its facilities to meet the increasing demands for their product. The pamphlet gives sizes and thicknesses of phosphor bronze sheet metal, wire, circles, rods, wire ropes, ingots, castings, alloys and "hardenings." Those using this material should procure this revised list of prices and secure the latest discount.

The Falls Hollow Staybolt Company, of Cuyahoga Falls, Ohio, have appointed the Republic Railway Appliance Company, of St. Louis, as their agents for the Southwest. Mr. E. S. Marshall is president of the latter company, and from his experience as superintendent of motive power of several important roads is specially well qualified to present the merits of this staybolt iron. He has used "carloads" of it himself. The manufacturers of this product, in a recent communication, say: "We are pleased to announce that the year just closed has been the banner year for us and the outlook for 1903 is still better. Falls Hollow Staybolt iron is fast increasing in favor owing to its many advantages over the solid or drilled bolt. We furnish solid staybolt iron made of the same high grade, double refined charcoal iron, as the hollow, to those who prefer solid material."
